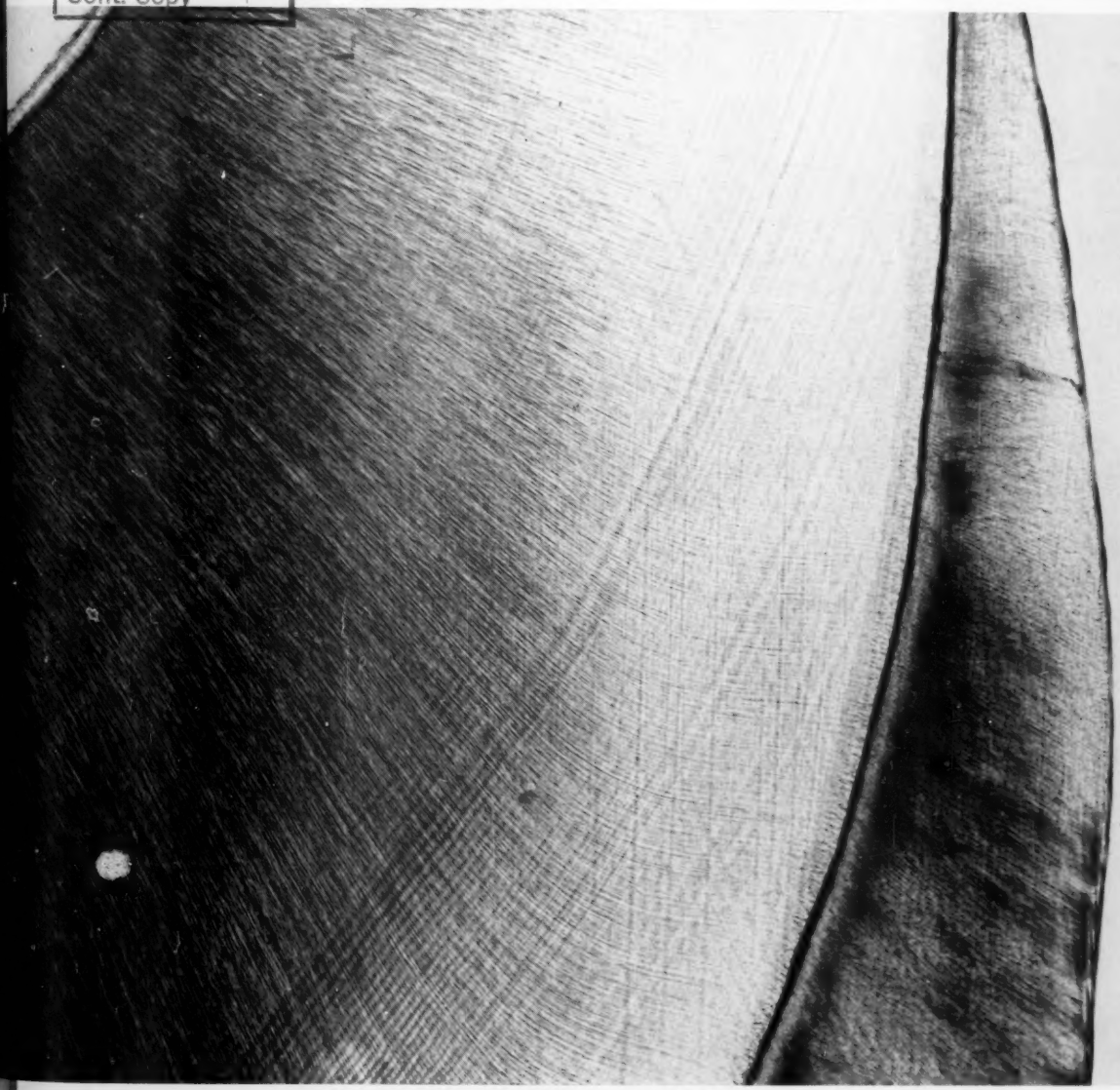
SCIENCE

18 December 1959

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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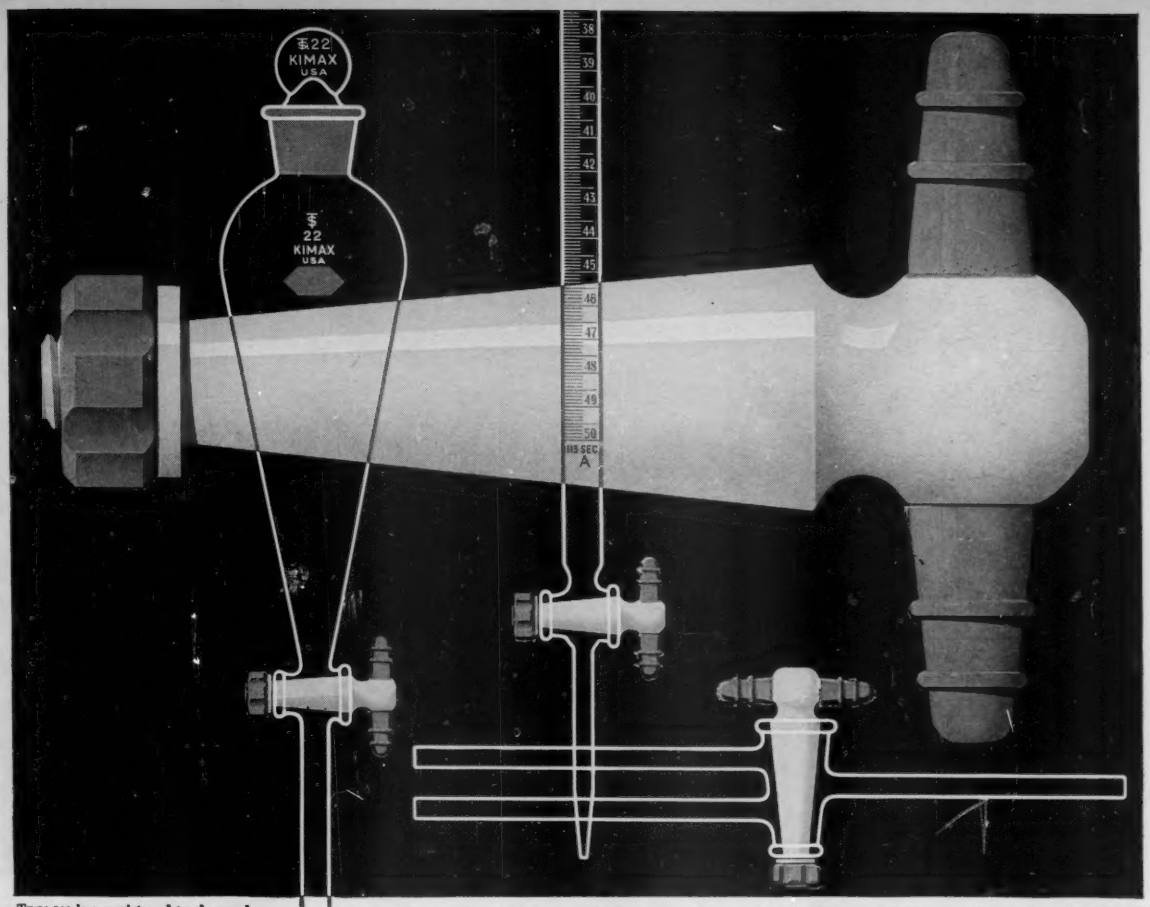

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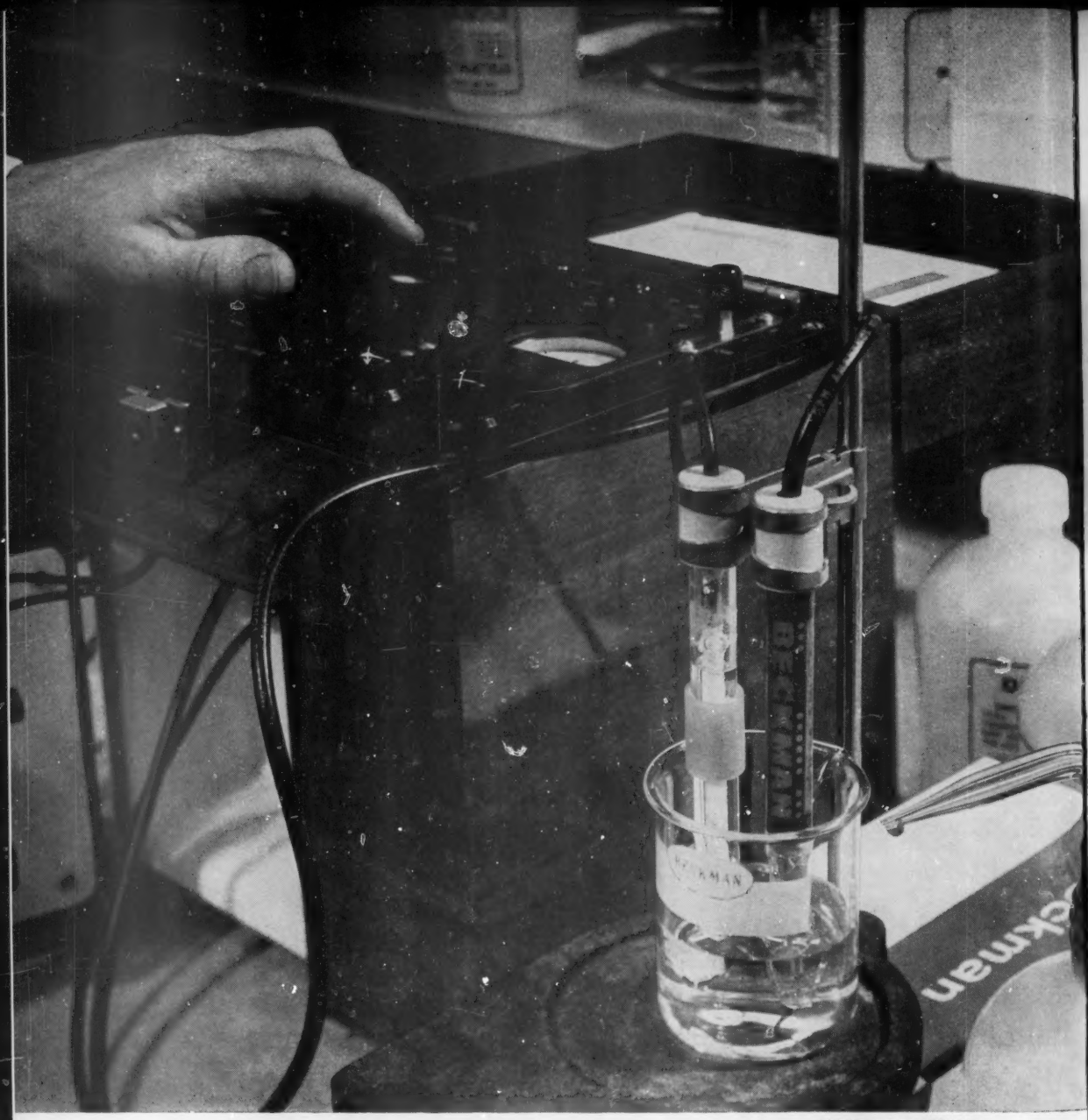

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Cover Microscopic section of monkey tooth. The pie-shaped area, upper left, is a segment of the "nerve" (pulp), which is lined by a row of cells (odontoblasts). Extensions of these cells radiate obliquely through minute channels in the bulk of ivory (dentin), and are intersected by delicate rhythmic growth lines, like rings of a tree trunk. On the right, the rock-hard "skin" of the tooth (enamel) forms a homogeneously mineralized shell of protection. Specimen from laboratory of Reidar F. Sognnaes. See page 1681.

Letters

Weathered Bedrock in New Jersey

The article entitled "Recent saprolite" that appeared in a recent issue of *Science* (*1*) is, in my opinion, an example of an extreme hypothesis and should, somewhere, have carried a statement to that effect. If the interpretation made by Minard regarding the length of time involved in the production of a thick saprolite in northern New Jersey should happen to be correct, a great deal of doubt could be cast on the use of the degree of soil development as an index for estimating relative amounts of elapsed time during the Cenozoic era. For this reason, as well as because many nongeologists may not be aware of the controversial possibilities in the article, I feel compelled to point out several arguments advanced by Minard that I believe to have resulted from faulty reasoning.

In order to support his hypothesis of exceedingly rapid weathering of the Pochuck gneiss at this place, Minard suggested that glacial abrasion would have removed it completely or would have greatly distorted the layering in the saprolite. He also argues that had it been overridden by the glacier while frozen, a congeliturbate structure should be found in the upper part of the material. Neither of these postulates is valid. Near its margin, an ice sheet can readily move over unconsolidated material without removing or distorting it. The ice lobes that passed through the Great Lakes basins buried many nearly complete soil profiles virtually undisturbed as much as 15 to 20 miles back from their margins (*2*); this saprolite locality is only 5 miles north of the glacial boundary in New Jersey.

Even though Salisbury's classic report on the glacial geology of New Jersey (*3*) was published in 1902, I am sure that it is not so obsolete that it can be disregarded completely. Salisbury stated that locally, near the last glacial boundary, till rests on disintegrated rock; in every observed case, relationships of the materials indicate that the ice had failed to remove the weathered rock. Similar statements were made in the Raritan folio (*4*).

Salisbury also reported that although striae are rare, those found on exposed bosses of gneiss in this vicinity indicated a direction of ice movement of about S 12°W. If these data can be accepted, this particular saprolite-covered ridge actually is 300 feet below the crest of a hill and partly protected on the lee side, one of the better places to search successfully for buried soil profiles in a glaciated region. Structures that might be called congeliturbates are rare near the southern limits of glaciation in Illinois, Indiana, and Ohio, although they have been reported from Pennsylvania (*5*).

MacClintock's study of the degree of weathering of gneissic cobbles in the drift of northern New Jersey was an attempt, which seems to have been reasonably successful, to relate differences in the degree of weathering of certain types of cobbles in the pre-Wisconsin drift to the age of the enclosing glacial sediment (*6*). The presence of weathered cobbles in unweathered ice-laid drift can be readily explained if one understands that glacial ice picked up chunks of saprolitic material as it moved forward. It then incorporated some of these chunks into the sediment without wholly destroying them.

Hunt and Sokoloff (*7*) did not present "evidence for rapid, deep weathering." Rather, they pointed out that we are in no position to evaluate time as a factor in the development of a paleosol unless we know much more than we do now about the climate and other aspects of the environment that existed where any particular old soil was formed.

The existence of a thick saprolite on gneiss in one locality, covered by a very thin layer of weathered drift, should be an indication that this thick weathered zone on the gneiss did not form under the same conditions of time and climate that produced a far thinner weathered zone on the same materials nearby. The depth of weathering (that is, removal of carbonates) of the Wisconsin till in New Jersey is not great, generally 2 to 3 feet, and rarely as much as 5 feet (*3*). Minard points out that about 10 miles south of this locality the saprolite blanket on unglaciated gneiss is 60 feet thick. I would find it far easier to accept a hypothesis that the 25-foot-thick saprolite in the locality under discussion is part of a pre-Wisconsin soil the ice failed to dislodge. Minard's postulate that it is the result of weathering during the past 18,000 to 20,000 years seems to me untenable.

As minor editorial points on Minard's article, the dates of his references 4 and 5 are incorrect, as is the publication number of his reference 5. His

(Continued on page 1719)

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A Thinking Man's Movie?

The film, *On the Beach*, which was unveiled 17 December in 18 cities covering all continents except Antarctica, concludes with close-ups of new-love found (Gregory Peck and Ava Gardner) and abiding-love reaffirmed (Anthony Perkins and Donna Anderson, a newcomer), but it does not have a happy ending. In fact, it ends with nothing less than the atomic death of the world. Based on Nevil Shute's best-selling novel, the film was produced and directed by Stanley Kramer, who has a reputation for tackling controversial subjects. A group of Americans, Australians, and Britons await in Australia the fatal radiation resulting from a nuclear war that has wiped out the rest of mankind.

What the story does is explore how people would behave during the final months of existence in the last niche of life on earth. Its finding is that people would behave much as they have always behaved. They would continue working at their places of employment; they would go away for the weekend if such was their custom. Even when lining up at government stations to receive suicide pills to hasten death, once the first symptoms of radiation sickness appeared, they would conduct themselves in orderly fashion.

The story does not pretend to explain how a group of nations came to oppose each other with automatic weapons of total destruction, although, at one point, a scientist (Fred Astaire, also, in a sense, a newcomer) says the immediate cause of war probably was an accident: someone misread a dial. Nor does the story seek to fix responsibility among scientists, government leaders, or ordinary people for the circumstances that made such an accident possible.

Not so long ago George Orwell presented us with a rather different look into the future. Such is the pace of events, however, that where the theme of *1984* is the end of man spiritually, the theme of *On the Beach* is the end of man physically—and the date of this happening is moved closer by a generation. And where *1984* is a plea to take the care necessary to preserve freedom, *On the Beach* is a plea to take the care necessary to survive.

The message of the film comes through. In the course of two hours and 13 minutes the audience attends to such ideas as that of a city deserted because all of its inhabitants are dead in their beds, and of a baby that must be fed and changed until the day when it gets a suicide pill of the dose recommended for infants. These ideas are powerful and the viewer is much affected, yet he leaves the theater with the feeling that he has been moved more by what he has brought to the film than by what the performance itself accomplished.

Staged against a background of atomic death, but making no real connection with it, are the postures and attitudes that have been recorded on celluloid so many times before. The scene is new but the action is familiar. Gregory Peck, the commander of a nuclear submarine, and Ava Gardner, a woman of the world, meet, are attracted, love, then must part. When last we see them, Mr. Peck is taking his ship to sea, noble yet sexy, while watching from the shore, Miss Gardner is fighting back the tears, sexy yet noble.—J.T.

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Dentistry at Its Centennial Crossroads

Prevention is the only rational solution to dental health; basic science, the only hopeful approach.

Reidar F. Sognnaes

Dental disease is now practically everybody's disease, and a great many people have begun to wonder what dental health, and the dentist bills, are coming to. Currently, we are seeing the dentist to the tune of over $1600 million per year, about one-sixth of our nation's total expenditure for health. If this sounds high, consider that there are nearly 100,000 dentists in the United States, yet that only one-third of the damage to our teeth is being repaired. Many communities are without dentists. Many families are dentally indigent. There is an estimated backlog of 700 million unfilled cavities in our population. Seventy percent of those over 35 years of age are in need of bridges and dentures because of teeth already lost or damaged beyond repair. With our people's increasing life span, the dental needs of the aged are growing steadily. It would take 250,000 dentists working for 10 years merely to eliminate the present backlog of common dental defects.

Even if we had enough dentists to do the job (there are no such resources in sight), the out-of-pocket cost of dental repairs would be only a fraction of the real cost. What should we allow as the value of working-time lost, pain endured, productivity cut, merely because of going to the dentist?

Today's dental researcher, however, is trying to discover the basic biological factors in dental health and disease. He uses innumerable refined research techniques of modern biological laboratories, exploring the new vistas disclosed by the electron microscope and the secrets revealed by tooth-and-bone-seeking radioisotopes. He is trying to find out how teeth and bones develop; how saliva affects the teeth; how gums and teeth give clues to bodily health and biological aging; how certain rare food elements affect oral conditions.

Notwithstanding this broadening scope of dental science, we are still merely scratching the surface of the problem. Modern dental technology, developed over the past century, is so good that people who can command the best have come to reconcile themselves to fillings, bridges, and plates, to pain and discomfort endured, to time lost and money spent. For the rest of the population and for the new generation, conventional repair will not solve the problem. Prevention is the only rational solution, research the only hopeful approach.

Increasing Support of Research

The recent history of the health sciences gives excellent assurance of positive developments. We have seen as much progress as one could ask for in return for our limited investment in dental science. For example, in the mid-twenties only 12 American dental schools out of the 43 then in existence had any funds at all earmarked for scholarly pursuits—a total of $41,270 for the entire country, an average of less than $1000 per year per school. Today, most of our 47 dental schools are in a position to conduct research. In the whole nation there are currently at least 500 active dental-science workers who have initiated various research projects basic to dental health.

Behind much of this encouraging growth is the federal government. In Bethesda, Maryland, 50 of the 1000 doctors working in the National Institutes of Health are now engaged in work in dental science; 25 of them are dentists, the other half, Ph.D.'s working in the National Institute of Dental Research (NIDR).

This program began just ten years ago, when the newly created NIDR sponsored research fellows in six extramural dental institutions, at a cost of $33,000. Little by little, additional funds were provided for specific research projects in dental schools. By 1958, the NIDR made a total of nearly 300 extramural grants, amounting to about $2.5 million dollars for the nation's dental research effort. Dental schools themselves finance some additional research. But even today the funds for scholarly pursuits are relatively limited, by modern standards of health education and research. The total endowment of the 27 privately supported dental schools in the United States is less than $10 million. Student tuition and dental-clinic fees are the principal sources of support. And yet, in the long view, what is especially encouraging about all this is the fact that a certain amount of dental research now has become a normal day-to-day activity in nearly all of our dental schools. Furthermore, many other scientific institutions—state, private, and industrial—are beginning to concern themselves one way or another with some aspects of research related to dental health and disease.

At the same time, today's technological developments for saving teeth are

The author is Charles A. Brackett Professor of Oral Pathology and acting dean of Harvard University's School of Dental Medicine.

being improved each year. The electric drill has been a boon to mankind in comparison with the treadle-operated drill of not too many years ago. Today, ideas for developing new "drills," more efficient and less painful, designed to operate on three completely different principles, are being explored. The air-brasive drill, in effect a miniature sand-blasting machine, was the first new approach (it proved to be not quite what the doctor ordered!). The ultrasonic drill, next in line and still in limited use, cuts into a tooth by vibrating an abrasive slurry against it at a very high frequency. The "jet"-propulsion drill, now on the horizon and showing perhaps the greatest promise, does its work by means of compressed air, or by a rapid stream of water, which turns the drill mandrel at speeds exceeding 200,000 revolutions a minute. In fact, even the electric motors are being revolutionized to provide increased speed, effectiveness, and painlessness; and in place of drill points of simple steel we now have carbide and diamond-tipped burs, stones, and wheels.

Together with this progress in the preparation of teeth for restoration have come techniques for making extremely fine-grained and accurate casting of inlays, crowns, and bridges; new and better dental alloys; new acrylic and other dental plastics; and countless other new appliances and materials. Last year the American Dental Trade Association was told that up to 80 percent of current sales of dental equipment and materials were products which only seven years before had been research curiosities.

But even in some of the technological areas of dentistry there are still gaping voids. For instance, we need a very much better material for the so-called silicate fillings which most dentists and patients prefer for conspicuous cavities in the front teeth. Such fillings are, to be sure, almost indistinguishable from the natural tooth. Unfortunately, that is their principal virtue. The silicate filling material is comparatively brittle and soluble in the mouth; it is not particularly friendly to the underlying tissue; it does not make a genuine physical or chemical bond with the living tooth; and considerable undercutting of the healthy part of the tooth is required in order to anchor the filling.

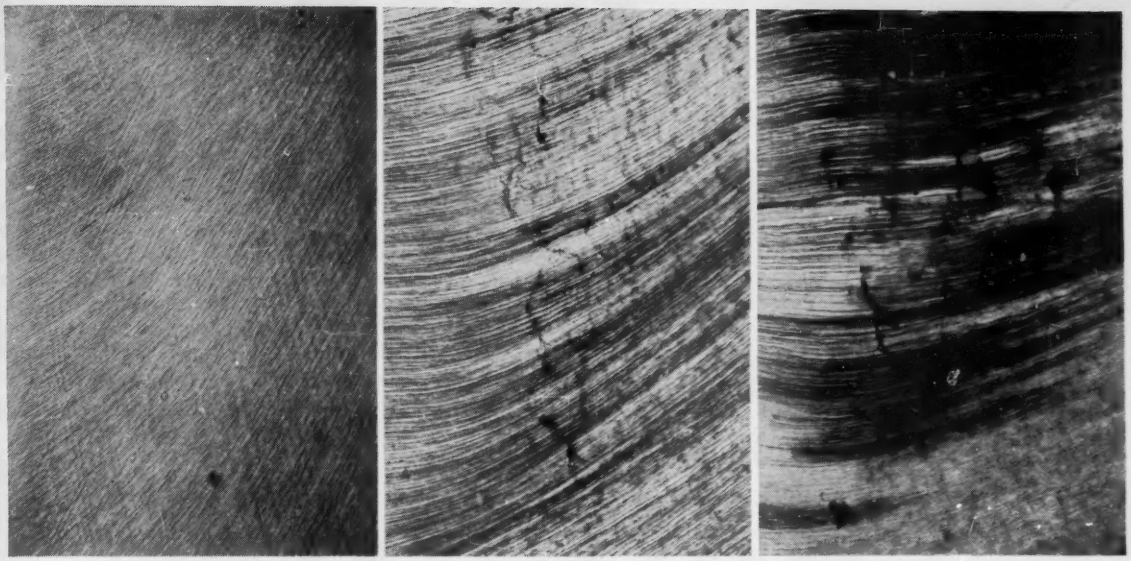
In today's world no scientist would say that this problem could not be solved. To solve it would be well worth while. It is estimated that our nation spends over $50 million per year on silicate fillings, and that in less than five years, on an average, these will require replacement. If one could do nothing more than double the life expectancy of such a filling material, the saving in money would be a handsome return on the investment in research. Still greater would be the value of time saved and discomfort avoided.

Much of the research in new materials and equipment is now being carried on by commercial organizations, although some schools still do work on the technological level. The National Bureau of Standards and the American Dental Association have to a large extent taken over from the dental schools the function of testing and certifying physical and chemical properties of products offered for use in restorative dentistry.

Nevertheless, the whole structure of standard restorative dentistry is still too much of a mechanical stopgap and not enough of a biological science. In prin-

New clues to biochemical interference with dental disease are now being sought through the use of tooth- and bone-seeking radioisotopes, here being traced with a Geiger counter in a wing of the radio-biology laboratory, initiated by the Atomic Energy Commission, at the Harvard School of Dental Medicine.

Sponsored by the new dental teacher-training program of the National Institutes of Health, a dental research fellow and staff sponsor at the Harvard School of Dental Medicine explore, with the aid of the electron microscope, the microstructural response of oral tissues to biological aging.

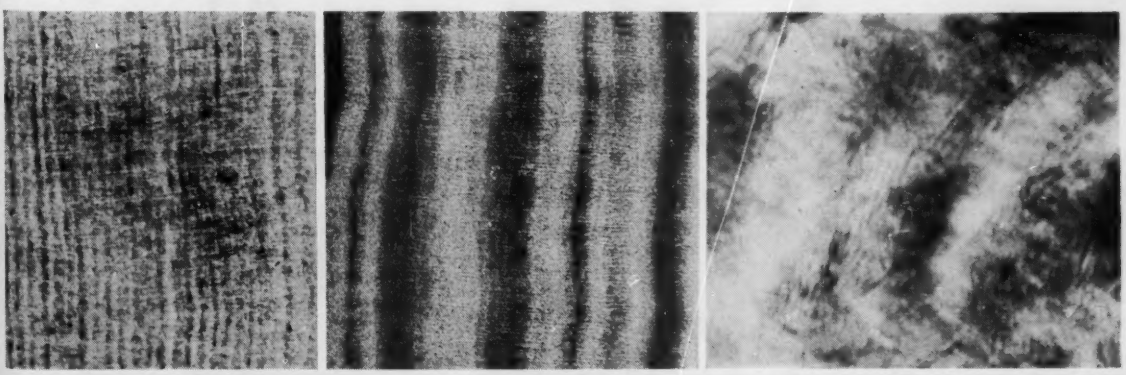


Comparison of the tooth structure of a monkey, an ape, and a man shows deterioration in the developmental quality of dentin, the ivory core of teeth. The rhesus monkey, from India, has beautifully calcified dentin (left). The wild chimpanzee of central Africa has dentin with faulty granular calcification (center). The dentin of *Homo sapiens*, even that in teeth from the prehistoric cave-dwellers of Mount Carmel, Palestine (right), exhibits completely uncalcified interglobular spaces, a widespread defect in modern man.

ciple, the filling of teeth is based on the admission that, within very narrow limits, cavities cannot be healed. A substantial number of cavities can be prevented by the fluoridation of public water supplies—an intelligent step in modern public health that unfortunately is vigorously opposed by a "militant minority." When cavities occur, they cannot be reversed. Treatment still must consist in removing healthy tooth substance far beyond the area of decay ("extension for prevention") in order to limit the inevitable recurrence of decay. But must we resign ourselves to endless retreat and rear-guard fighting? Can't we take the initiative and attack the enemy before he attacks our teeth?

Broadening Scope of Research

Largely as a result of recent federal research support, we have learned a good deal about the most common of the oral diseases—the most common of all diseases—tooth decay. Now cavities can be induced at will in laboratory rats for more precise study of cause and prevention. The old slogan that "a clean tooth never decays" has come under thorough study and has stood up to the most rigorous testing in experiments with germ-free and tube-fed rats. It is only too evident that the conventional oral cleaning approach to the tooth-decay problem has been wholly inadequate. Yet, there is obviously no gaping flaw in our theory. The trouble

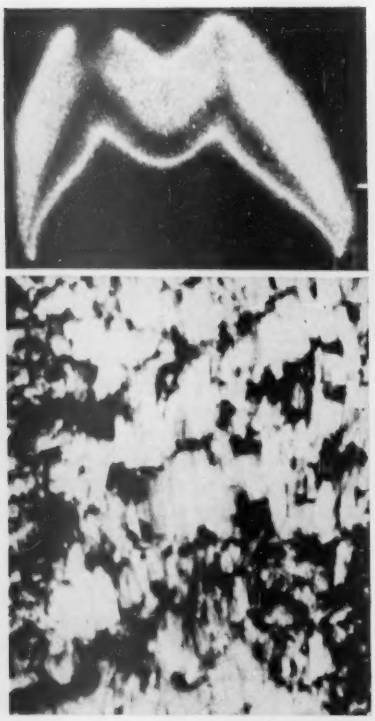


Ivory, big brother of the dentins and first cousin of bone, as seen by means of optical (left), x-ray (center), and electron (right) microscopy. Transmitted light reveals, at left, a regular rhythm of vertical growth lines, whereas the microradiograph in the center shows that ivory is, in fact, subdivided into broad layers of high and low (dark) microdensity, readily seen at a magnification of 100. When much thinner sections of ivory are studied with the electron microscope at a magnification of 200,000 (right), the ultimate inorganic apatite building blocks look like miniature cigars the size of exclamation points, similar to those in other dentin and bone.

seems to be that a clean tooth simply does not, in fact, exist—at least one that is clean from a microbial point of view, and that apparently is what counts. We now have to face up to the prospect of undertaking long-term exploration of other underlying influences on tooth decay—nutrition, genetic factors, ingredients of saliva, and so on.

From circumstantial evidence, we know that saliva is important to oral health. When the salivary glands are destroyed by radiation or removed by surgery, rampant tooth decay occurs very quickly and the gum tissue is more likely to become inflamed. It would seem to be a simple matter to determine the composition of saliva in a normal mouth and compare it with the saliva in a diseased mouth. But unhappily, unlike blood and other body fluids, which have a critical base-line composition readily established by standard methods, saliva fluctuates over a wide range as far as the common body chemicals are concerned. Yet, it is altogether probable that more intensive research may reveal that some unknown ingredient of saliva, possibly organic in nature, is of diagnostic significance and as important to the mouth as blood itself is to the rest of the body. Though we have done some searching, this area is still wide open for research.

We know far too little about the deeper secrets of etiology, pathology, and prevention. A case in point is the condition known as pyorrhea, characterized by inflamed and receding gums, rapid destruction of the jawbone, and the falling out of otherwise useful teeth —a widespread problem in our aging population. It is a curious fact that this disease can occur even in individuals who in other respects seem altogether well, showing no systemic illness even under the most searching diagnostic observation. The long bones of the patient's body may be quite normal, and nothing untoward shows in his organs or body fluids.



Modern biophysical research tools are now being brought to bear upon the hardest tissue of the human body, the dental enamel, which covers the visible crowns of the teeth. (Top) An autoradiograph of the calcifying molar of a monkey, after intravenous injection of radioactive phosphorus, shows distinctly different patterns of phosphate deposition in the enamel and in the dentin (bright inner contour line). (Bottom) Electronmicrograph (× 50,000) of calcified enamel, sectioned with a diamond knife, shows an orderly array of pencil-shaped apatite crystals, much larger in size than those seen in rapidly calcifying ivory, other dentin, and bone. [From joint studies with Dr. James Shaw (top) and Dr. Robert Frank (bottom)]

(Top) The dental clinic of the first university-affiliated dental school, two decades after its establishment at Harvard in 1867. (Bottom) Dental students in clinic at the Harvard School of Dental Medicine today.

On the other hand, an occasional older person may show signs of skeletal disease, such as osteoporosis—the "Swiss cheese bone" condition that sometimes accompanies menopause—but the bones of the jaw will appear to be unaffected. Yet, sometimes it is in the mouth and the jawbone that the signs of a general bodily ailment, such as the hormonal disease known as hyperparathyroidism, may be first seen. These are but a few examples of the seemingly complex oral health problems that, so far, have defied our limited efforts at control and prevention.

Some aspects of dental research suggest that this is a more difficult field of science than we have thought. The primary site of decay, the dental enamel, "hard as a rock," is unique in the human frame because it is indeed a kind of rock. The enamel appears unbiological in that it is made up of mineral crystals instead of cells; it is so remarkably hard that only a diamond or hardened steel can scratch it. Enamel contains no blood vessels or nerves. It seems impervious to protective body fluids and antibodies from within and, unfortunately, equally unaffected by man-made "wonder drugs" and antibiotics that work directly through blood and cells. Nevertheless—or perhaps *because* of these peculiarities—most people do experience tooth decay, which begins with a pitting of this diamond-hard and impermeable enamel. Once the enamel is breached, a cavity inevitably forms in the dental ivory below. No known bodily process prevents the cavity from growing larger, ultimately infecting the underlying "nerve" or pulp of the tooth and causing abscesses and infections in the jawbone, which occasionally spread beyond the jaw, directly to the adjacent organs or to the valves of the heart. Attainable knowledge could change this course of events.

Steppingstones to Better Health

It is abundantly clear, from the history of the health sciences, that there can be a considerable time lag between the steps through which basic research exerts its full impact upon education and, in turn, upon practice.

The British Royal Society, officially recognized in 1662, was the first to establish opportunities for full-time devotion to scholarly pursuits in basic medical science, albeit with an eye fixed on specific disease problems, notably tropical diseases. The French Academy of Science, which in 1816 became a branch of the Institute of France, stimulated research both in biological and natural sciences. In 1885, Louis Pasteur's work, through the springboard of chemistry, became extended in scope and time by the productive medical research institute named after him, in Paris. The German Koch Institute,

William T. G. Morton, a Boston dentist, giving the first public demonstration of ether inhalation for surgical anesthesia, on 16 October 1846, in the Bulfinch Building ("ether dome"), still a part of the Massachusetts General Hospital in Boston. In the room there now appears the following inscription: "On October 16, 1846 in this room, then the operating theatre of the Hospital, was given the first public demonstration of anaesthesia to the extent of producing insensibility to pain during a serious surgical operation. Sulphuric ether was administered by William Thomas Green Morton, a Boston dentist. The patient was Gilbert Abbott. The operation was the removal of a tumor under the jaw. The surgeon was John Collins Warren. The patient declared that he had felt no pain during the operation and was discharged well December 7. Knowledge of this discovery spread from this room throughout the civilized world, and a new era for surgery began."

in 1891, grew out of the Institute for Infectious Diseases, spurred by the discovery of the causative agents involved in tuberculosis and cholera. Many medical research centers created scholars in Germany (the Kaiser Wilhelm Society), in Sweden (Karolinska Institut), and elsewhere. And in England the Lister Institute (the British equivalent of the Pasteur Institute) concerned itself with basic research as well as with serum and vaccine preparation; the British Medical Research Council Laboratory at Hampstead, with experimental pathology, applied physiology, therapeutic drugs, and biometrics.

In this country the National Academy of Sciences was established during the Civil War to advise on national problems, including health and disease. But it was at the turn of the century that the boldest step toward scientific medicine was taken—the generous endowment of the Rockefeller Institute for Medical Research in New York, in 1901, "for the purpose of research in any field that gave promise of a return in medicine." From the Rockefeller Institute, vital and vitalizing information emerged, covering a wide range of basic medical sciences (biophysics, biochemistry, physiology, experimental and comparative pathology), as well as disease-oriented research (on metabolic disturbances, infectious diseases, experimental surgery, and heart disease).

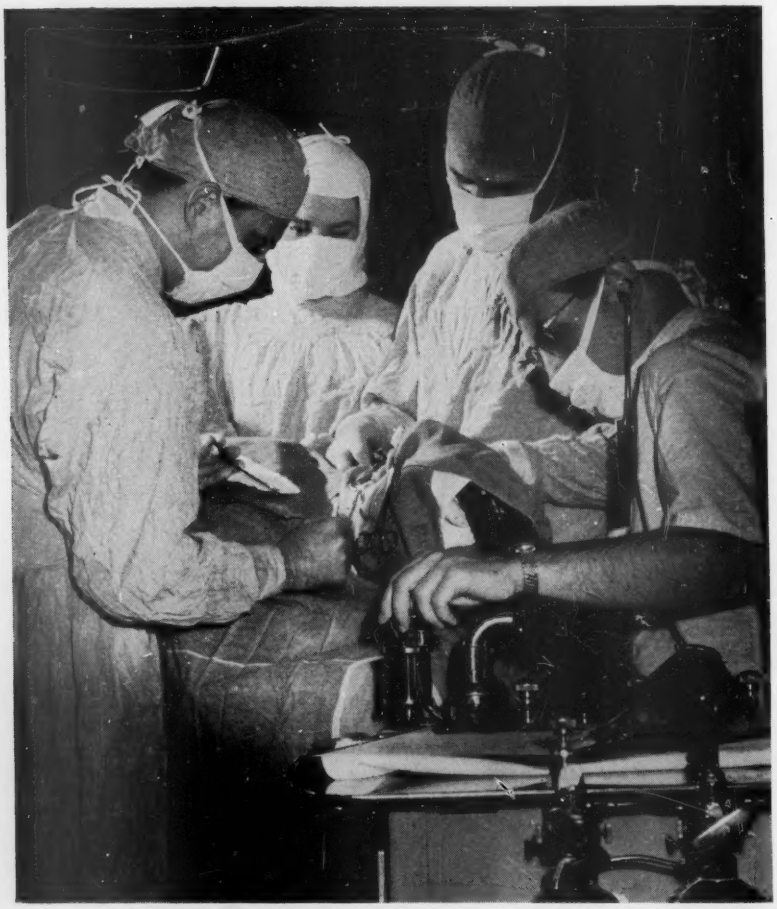
Not only did these research institutes contribute to the understanding and prevention of disease; they were feeding knowledge worth teaching into medical schools the world over, introducing new concepts and principles that challenged the best intellects. "Over and above this immediate result," Abraham Flexner observed later, "it is something to possess in every country institutions in which earnest men of all races and nations cooperate for ends that obliterate national lines" (*1*).

Notwithstanding these long and glorious traditions in medical research, Abraham Flexner found little impact upon medical education and practice when, in 1910, he reviewed the country-wide situations in the United States and Canada (*2*). But through his broad insight he could propose remedies for which there were already tested prescriptions.

The teacher-researcher, the physician-scientist, was a well-established entity in the centers of medical learning in Austria, Germany, France, and Britain. In the United States medicine had, in addition to the flourishing Rockefeller Institute for Medical Research, a pioneering university medical school, Johns Hopkins, molded according to the best traditions of medical research, teaching, and patient care known to 20th-century physicians. These were the steppingstones to scientific medicine.

When William Gies, 16 years later, surveyed the status of academic dentistry in the United States and Canada (*3*), he recognized that there had been great technical developments, but he found that for academic standards comparable to the best in medicine, there was no place to look but ahead. There were no research institutes for dental science (our National Institute for Dental Research was established in 1947, its building will be completed in 1961); there was no prototype (comparable to Johns Hopkins) for academic centers of learning in dentistry to show what an environment of scholarship and excellence could do for the educational standards of a dental school; there was not sufficient basic information about the oral cavity to bring biological science to bear upon the teaching of dental students and the care of dental patients.

Can dentistry be expected to progress as medicine has progressed if tested steppingstones are by-passed? Gies did not think so. Thirty years ago, after reviewing the status of academic dentistry in the United States and Canada, he made this recommendation (*3*, p. 237): "In order to strengthen dental education at the point of its greatest weakness, funds sufficient to enable the school to pay adequate salaries must be provided, and suitable means must be devised for the selection and training of the most competent prospective teachers and investigators. Fellowships and special



Modern oral surgery under general anesthesia at the Massachusetts General Hospital, directed by the chief of dental service and attended by students from the Harvard School of Dental Medicine.

funds are needed to encourage and support advanced study and research by the most promising candidates for whole time teaching positions."

Two significant steps in this direction were taken in 1929, when the Rockefeller Foundation provided equal grants to Yale University and the University of Rochester to enable a selected group of dentists to broaden their medical-science base and gain research experience. Men of leadership emerged.

But Gies looked to the root of dental education, the environment where the dentists themselves are educated in the first place (neither Rochester nor Yale have undergraduate dental schools), when he concluded (*3*, p. 240): "The dental schools in this country and in Canada, lacking endowments and in most cases being obliged to keep the quality of their work to the level of their income from fees, will be unable to proceed with the suggested improvements unless, individually, they receive large gifts of funds for the purpose."

The same can be said today. Only when the dental schools themselves become more adequately supported and staffed for scholarly pursuits can the spirit and method of science be more fully incorporated into the fabric of dental education and practice.

Education of Dental Researchers

On the basis of analogies to many other areas of disease, it is reasonable to assume that the answers to questions in dentistry will be interrelated, and related, as well, to problems in the other health sciences. One may suppose, therefore, that the thousands of medical researchers in hospitals and biological laboratories will eventually produce clues and even, perhaps, solutions. If and when they do, it may be by happy accident—fortunately accidents can occur in science—rather than by design. These health researchers, focusing on a host of dramatic disease problems, have their hands full, and we may have to wait for several generations for specific contributions to dental health.

Meanwhile, the busy practicing dentist is not likely to drop his practice and begin learning to be a biological research worker; nor can the chemist, physicist, or scientist in some other discipline be expected to desert his work and begin to study the problems of dentistry. A more realistic approach than that of simply waiting for miracles from researchers in other disciplines or from established dental practitioners would seem to be the fostering of a new strain of biological scientists with established interest and experience in dentistry. These new dental scientists could and should be trained from the ground up, within the university; but to attract some of the scientifically motivated young dental graduates into this unexplored field would require substantial support for postdoctoral research training. Through this approach the smallest investments are sure to pay significant dividends.

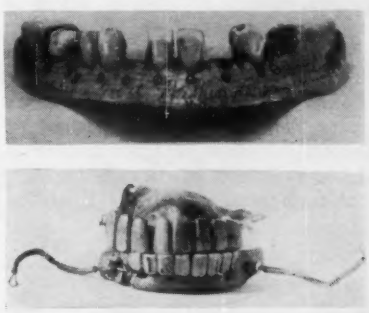
Such support has been enormously productive in medicine. During the past five years, $100 million was allocated to medicine by the National Institutes of Health for university and hospital training of medical researchers. The first similar step in dentistry was taken in 1957, with an appropriation through NIDR of half a million dollars, divided among 16 dental schools, for the training of teacher-researchers in the dental field. If extended through governmental as well as private support, such advanced training of scientists and academicians in dentistry could become an important first move toward ultimate achievement of dental health.

The ground has already been prepared. Today's students are receiving a good foundation in biology upon which to build. For example, at the Harvard School of Dental Medicine, the dental students have been afforded the opportunity, since 1943, of spending their first two years beside the medical students, taking exactly the same courses under the same professors and being exposed to the same high standards and climate of expectancy. The first two years of biological science are followed by two years of practical work in diagnosis and treatment in the clinics of the dental school and its academically associated institutions, Massachusetts General Hospital, Children's Hospital, and Forsyth Dental Infirmary. In addition, each dental student is granted the privilege of working with a faculty sponsor on a problem of research. With this foundation in biological science and patient care, the young doctor of dental

WHEREAS many Perſons are ſo unfortunate as to loſe their Fore-Teeth by Accident, and otherways, to their great Detriment, not only in Looks, but ſpeaking both in Public and Private :—This is to inform all ſuch, that they may have them re-placed with falſe Ones, that looks as well as the Natural, and anſwers the End of Speaking to all Intents, by *PAUL REVERE*, Goldſmith, near the Head of Dr. *Clarke*'s Wharf, *Boſton*.

*** All Perſons who have had falſe Teeth fixt by Mr. *John Baker*, Surgeon-Dentiſt, and they have got looſe (as they will in Time) may have them faſtened by the above, who learnt the Method of fixing them from Mr. *Baker*.

Paul Revere, in announcing his dental practice in the Boston papers in August 1768, credits as his preceptor an Englishman, John Baker, believed to be the first qualified dentist to practice in this country. [From B. W. Weinberger, *History of Dentistry in America* (Mosby, St. Louis, 1948)]



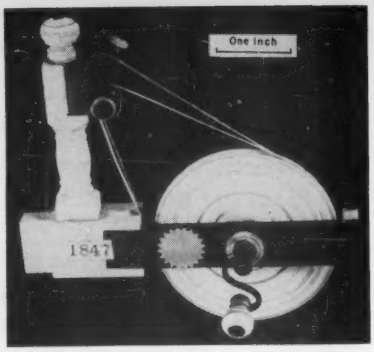
Two of George Washington's "bridges." (Top) Lower plate carved from hippopotamus ivory by the New England dentist John Greenwood in 1789. (About × 1.3) (Bottom) Ivory teeth inserted onto a full lower and upper set, believed to be the first known example of gold swaged plates. The spiral springs pressed the dentures against the gums and were altered by Greenwood according to specifications by Washington himself in 1798. [From B. W. Weinberger, *History of Dentistry in America* (Mosby, St. Louis, 1948)]

medicine, in addition to acquiring clinical dental skills, is also on the road to becoming a biological scientist. Through further postdoctoral activity and growth, he may find that he is developing a special field of practice, or an area of special research interest which may lead toward an academic career in dentistry.

This new strain of dental scientist and specialist is being bred through various other programs. Some schools emphasize studies implementing the basic laboratory sciences, others concentrate on specialized clinical training. Such advanced postdoctoral education for dentists represents one of the United States' most important new contributions to modern dentistry. In increasing but still relatively small numbers, men with broad training are coming out of the dental schools, to join the faculties of other dental schools, here and abroad, and to work in research laboratories, in clinics, and in private dental offices.

A Change in Emphasis

It is a century now since organized dentistry became established in the United States, in 1859. A dozen years earlier a Boston dentist, William Morton, had already demonstrated to the satisfaction of doctors and patients everywhere the anesthetic effect of sulfuric ether, using it successfully for painless surgery at Massachusetts General Hospital. The fact that this blessing to humanity was established by a dentist is perhaps not especially significant, but dentists like to think that it was altogether appropriate, and even symbolic: the relief of pain and the painless removal of irreparably decayed, loose, and abscessed teeth had always been a prime concern of dentistry. Then came the long series of groping advances in restorative dental techniques. Little by little it was learned that painful teeth need not always be pulled,



A tusk for a tooth auger. Century-old hand-turned dental "engine" with a handle for drill chuck and a pulley wheel made of ivory.

that at least some could be saved. Through this realistic "first come, first served" approach, dentistry has arrived at a point where the modern dentist can all but improve upon nature, as sparkling smiles from Hollywood to Washington amply demonstrate.

In a paradoxical sense, dental art and technology may well have become too good, too soon, for the good of dental science and biology. The clumsy, uncomfortable "sea-horse" dentures of hand-carved hippopotamus ivory of an earlier day (neither President Washington nor the kings of Europe could command anything better) have long been replaced by light-weight dentures, bridges, and crowns hardly noticeable to the wearer, or to anyone else for that matter. In the realm of restorative materials and techniques, we still can expect further improvements. But there is now a new "first": The goals have been moved away from extraction and restoration to control and prevention. The pioneers of the new frontiers of dentistry are the dental research workers who seek to know "why" as well as "how."

The way to dental health is clear. Step number one is to implement the research training for dental scientists. This requires substantial long-term support. To get this under way the federal government must step in with support specifically earmarked for the training of teacher-researchers, until dental schools come to attract a greater share in endowments by private foundations. Among the 4000 philanthropic foundations listed in *American Foundations and Their Fields*, six are already specifically naming dentistry as within their field of interest, and four of these cite advances in dentistry as being among their major aims. The Kellogg Foundation, one of these, now supports a Commission for the Survey of Dentistry. Step number two is to enable properly trained dental scientists to pursue basic research on a long-term basis rather than be confined to narrow, short-term projects. Step number three is for this new breed of dental scholars and investigators to extend and deepen their collaboration with scientists and experts in other fields, in situations ranging from laboratory research to "chair-side" and bedside patient care.

Ultimately, this three-pronged approach will elevate the whole triad of teaching, research, and service for dental health. American dentistry, now at its centennial crossroads, has a challenging future. The Pasteur and the Salk of dental health could well be just around the corner. To support the growth and development of this new strain of oral biologists is our best investment in dental health—in the health of those who are expected to be on their feet and to do their jobs—practically everybody's health.

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Effect of Soil Nutrients on Plant Uptake of Fallout

Soil calcium and potassium decrease strontium-90/calcium and cesium-137/potassium ratios in plants.

Eric B. Fowler and C. W. Christenson

The role of strontium-90 in the biosphere has reached marked prominence within the past decade. It is one of the products of nuclear fission (*1*); it has been shown to be a possible carcinogenic agent (*2*); and it has an appreciable half-life. Further, it is a close periodic relative of calcium; its relation to calcium metabolism has been reviewed (*2*).

Libby (*3*) and others have investigated the problem of strontium-90 fallout and have indicated the importance of the plant in the biological chain of transfer from soil to animal, to milk, and hence to man.

Collander (*4*) in 1937, using milligram amounts of calcium and strontium, showed that lettuce took up 500 times as much calcium as strontium. However, the ratio of calcium to strontium in the nutrient was of the order of 400 to 1. He places calcium and strontium in the same group relative to availability and relates availability to electrical mobility of the ions. If the work of Collander employed nutrient solutions, as is indicated, the results are probably not applicable to soils [see also (*5*)].

It was the purpose of the investigation discussed here to study the uptake of strontium-90 by plants growing in the presence of known amounts of the radionuclide and controlled concentrations of calcium.

Methods

Field tanks were chosen for this study, rather than greenhouse pots, to more nearly duplicate field conditions. Thirty tanks, each 5 by 5 feet and 2 feet deep, were filled to a depth of 18 inches with a soil composited from local Los Alamos soil, clay, and barnyard manure in the ratio of 4 to 1 to 1. The parent material of local soil is tuff, high in silicious matter and low in organic matter, with a low ion-exchange capacity. To assure uniformity, the separate fractions were passed through a shredder and then combined in the proper proportions and repassed.

A final mixing of the soil, radionuclides, and calcium was accomplished in a ½-yard concrete mixer; the radionuclides and calcium, as the chloride, were brought into solution and pumped into the mixer as tumbling was taking place. The use of calcium chloride was indicated because preliminary laboratory experiments had shown that calcium carbonate would not be available to the plant in this soil. Uniformity of distribution was determined by an analysis for leachable chloride, on the assumption that even distribution of calcium chloride indicated even distribution of the added radionuclides. The average variation among 90 random samples was less than 1 percent.

The concentration of strontium-90 and cesium-137 was such that 50 counts per minute per gram of soil were obtained. Preliminary calculations indicated that this level of activity would yield crop samples with satisfactory counting statistics. The amount of calcium chloride was varied from 1.5 to 18.1 milligrams of calcium per gram of soil in five increments. The intrinsic available calcium concentration of the mixture was 1.5 milligrams per gram of soil, and this level served as the control.

In addition, one tank received 1.5 milligrams of calcium per gram of soil, applied as calcium carbonate, and each of three tanks received 1.6 milligrams of strontium, applied as strontium nitrate, per gram of soil in lieu of calcium. Two tanks received spiked solutions applied at the surface with a sprinkler.

The average exchangeable potassium in 25 random samples of soil was 1.14 milligrams per gram of soil; the maximum was 1.25, and the minimum was 1.00. The soils were considered to have nearly uniform exchangeable potassium content.

The *p*H of the soils in the plots varied from 7.2 to 8.0. The *p*H of soil in two of the three control plots was 8.0; that of soil in the other plots varied in a random manner from 7.2 to 7.8.

Seed planted in soils containing more than 8 milligrams of calcium per gram of soil did not germinate uniformly; hence, to obtain uniform germination, untreated soil was overlayed to a depth of 2 inches on each tank, and this layer was reseeded to the respective crops.

The three crops grown in the 1957 season were lettuce, alfalfa, and mixed grass (*6*). These were randomly planted in replicate, except that only one control tank was used for each crop. Three crops were harvested; dry and ash weights were determined on samples of 100 grams cut weight per tank. All determinations were based on the ash weight of the sample. Plant ash was digested with 6*N* hydrochloric acid and made to volume in preparation for analyses.

Analyses were performed for calcium, strontium-90, and potassium by conventional methods. Available calcium in the soil samples was extracted with 1*N* ammonium acetate (*7*), and the respective concentrations were determined by flame photometry. Except for the plots to which strontium nitrate was added, all strontium data are given in counts per minute. The limit of detection of stable strontium by the method used is of the order of 2.5×10^{-3} milligram per gram. Strontium above this limit was not found in any of the soils. The amount of strontium added as strontium-90 was of the order of 10^{-12} gram per gram of soil.

Results

Ratios of strontium-90 per milligram of calcium in the plant were calculated and plotted against the concentration of calcium per gram of soil. Typical results are shown for two cuttings of lettuce in Fig. 1. It should be noted that in

The authors are affiliated with the Health Division of the University of California's Los Alamos Scientific Laboratory, Los Alamos, N.M.

each case the concentration of strontium-90 based on plant calcium decreased as soil calcium increased. The first increments of soil calcium effect the most marked reduction in the strontium-90/calcium ratio in the plant; the curves break at about 4 to 6 milligrams of calcium per gram of soil and tend to level off after 9 milligrams of soil calcium has been reached.

The data in the middle section of Fig. 1 depict the results obtained from two cuttings of grass. The slopes of the curves are similar to those observed in the case of lettuce. It will be noted that grass accumulated a greater amount of strontium-90 per unit of calcium than did lettuce or alfalfa. This was especially true at the lower concentrations of soil calcium, where the strontium-90/calcium ratio in grass was 1.7 times that found in lettuce. The anomalous value at 18 milligrams of calcium per gram of soil is an average of four determinations and is believed to be real; it is possible that this high concentration of soil calcium may release strontium-90 from the soil colloid (this is discussed below).

The data relative to the adsorption of strontium-90 by alfalfa are presented in the right-hand section of Fig. 1. It is of interest that a lower strontium-90/calcium ratio is found in this plant than is found in lettuce or grass. The ratio is lower than that found in lettuce by a factor of 1.5 and lower than that found in grass by a factor of 2.5. The slopes of the curves are not as great as those found in lettuce and grass; this indicates that soil calcium has less effect in alfalfa upon adsorption of the radionuclide.

The calcium concentration in the crop ash also varied with the type of plant. It was higher in alfalfa than in grass by a factor of 10, and higher than in lettuce by a factor of 4.

The foregoing data indicate that increasing the concentration of soil calcium from 1.5 to 9.0 milligrams per gram of soil has a marked depressing effect on the concentration of strontium-90 per milligram of calcium in the plant.

Romney (*8*) has since indicated an inverse relationship between strontium-90 concentrations in the plant and available soil calcium.

Data were obtained from a comparable set of experiments (*9*) in which the soils were mixed with cesium-137, and the effect of potassium on this radionuclide was investigated. An increase, by a factor of about 2, in exchangeable soil potassium decreased the cesium-137/potassium ratio in alfalfa by a factor of about 9.0. The reduction factors for lettuce and grass were about 5.

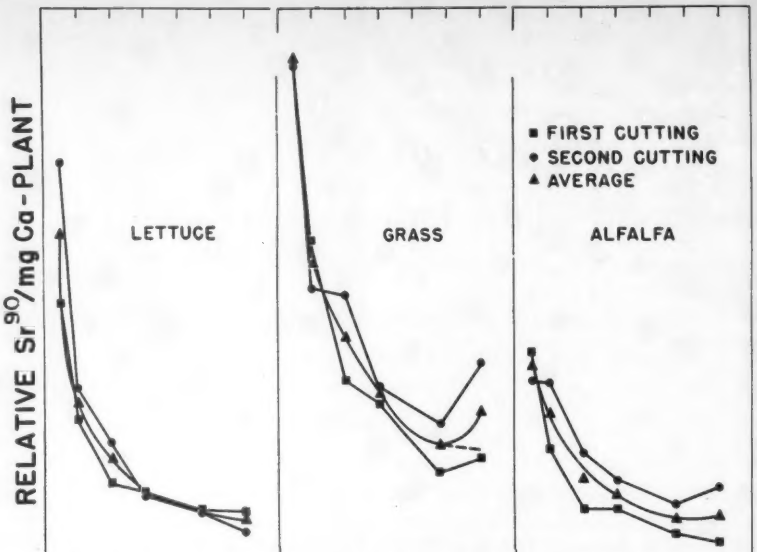

Fig. 1. Effect of increasing increments of soil calcium on strontium-90 uptake in plants.

Libby (*3*) has reported a discrimination on the part of the plant against strontium-90. The curves in Fig. 1 suggest that discrimination is related to the type of plant and to the concentration of soil calcium. To determine the presence and extent of such a factor, the ratio strontium-90/milligram of calcium (soil) was divided by the ratio strontium-90/milligram of calcium (plant) for the three crops; the data were treated statistically. The results fell into three groups—roughly, high calcium, low calcium, and an intermediate range; these are presented in Fig. 2.

Discrimination against strontium-90 per unit of calcium added was most marked with the three crops when calcium concentrations were low. Lettuce and alfalfa demonstrated discrimination against strontium-90 at soil calcium levels up to 13 milligrams of calcium per gram of soil. However, at concentrations of 18 milligrams of calcium per gram of soil, the plants appeared to discriminate against calcium; this is especially true of alfalfa and grass. It is possible that the high concentration of soil calcium may release some of the strontium-90 which is bound to the soil colloid and thus make it more readily available to the plant. Other data indicate a possible disturbance of the plant's physiology, lettuce being more tolerant to calcium than is grass. It should be stressed that these data show trends and are not meant to imply absolute values. However, it is indicated that the type of plant as well as the calcium level is associated with discrimination against strontium.

Stable strontium nitrate was substituted for calcium in three plots at a level of 1.6 milligrams of strontium per gram of soil. The calcium level in the strontium-treated soils was comparable to that in the low-calcium soils. It was believed that the addition of stable strontium would decrease the strontium-90 uptake by physical dilution, and hence apparently increase the discrimination against strontium-90 by the plant. However, in the case of lettuce the discrimination against strontium in the stable-strontium plots was very similar to that obtained for the low-calcium soils (Fig. 2). When discrimination factors were calculated for alfalfa and grass grown in stable-strontium tanks, the factors were lower than similar factors obtained on low-calcium plots. Romney (*10*) has since observed a similar phenomenon with Ladino clover and attributes this to replacement of the strontium-90 on the soil colloid by stable strontium. As suggested above, a similar reaction may take place when the soil colloid is flooded with calcium, and thus in the soils where a large amount of calcium was added, the

strontium-90 may have been released from the colloid and become available to the plant. Such a phenomenon could account for the decrease in discrimination factors with increase in soil calcium, as seen in Fig. 2, and for the apparent lack of a dilution of strontium-90 by stable strontium.

The highest discrimination (about 2.9) against strontium-90 was shown by alfalfa (Fig. 2), and the least discrimination (about 1.6) was shown by lettuce. It is interesting to contrast these values with those obtained for cesium-137 in a separate study (*9*). Alfalfa again discriminated to the greatest extent, but in this case the value is about 1150; grass discrimination is least, about 750. These marked differences are attributed to the greater binding of cesium to the soil, which makes it less available to the plant. Nishita *et al.* (*11*) also have since attributed the low uptake of cesium-137 by plants from soils to the nonavailability of the radionuclide.

In one case, calcium chloride was replaced by calcium carbonate to the extent of 1.5 milligrams of calcium per gram of soil, and the plot was planted to lettuce. This calcium did not have an effect comparable to that produced by calcium chloride. It is believed that the salt was not solubilized in this alkaline soil and thus that the calcium was not available to the plant. It is probable that calcium carbonate applied to an acid soil would be solubilized and would produce an effect comparable to that demonstrated with calcium chloride.

The results presented thus far have been concerned with the effect of calcium concentration on uptake of strontium. The soils were also spiked with cesium-137. The tanks which received a surface spike of cesium-137 yielded interesting preliminary data with regard to the zone of feeding of the plant, since cesium does not move easily through the soil.

In the tanks where cesium-137 and strontium-90 were applied as surface spikes, the average count of these radionuclides per gram of alfalfa ash from the first and second cuttings was only one-seventh the average for plants grown in similar tanks which were uniformly spiked. It would appear that the zone of feeding is associated with the area of root growth; this area moves progressively downward with the development of the plant. The implication with regard to fallout is important, since it has been suggested that fallout is presently concentrated within 2 to 4 inches of the surface (*12*). It was pointed out above that seeds were planted in a layer of untreated soil 2 inches deep. Further evidence supporting the importance of depth of feeding is offered by the observed concentration of radionuclide in the first and second cuttings. Since these concentrations were essentially the same after 5 to 6 weeks of growth as after 12 weeks of growth, it is apparent that the plants were feeding below the 2-inch untreated soil level at an early period in their development. The 2½-inch depth figure commonly occurs in the literature. It is our opinion that when strontium-90 concentrations in this depth are used to calculate discrimination factors, the results may be misleading. From our results we believe that absolute discrimination factors may actually be less than those reported. Menzel (*13*) has reported a Ksr equal to 0.38, which we believe translates to a discrimination factor, as calculated by us, of about 2.8. However, his results were obtained with bomb debris, part of which might be unavailable to the plant, and this would influence the calculation.

At the time of the third cutting, there was some evidence of leaching of calcium from the high-calcium plots, due to heavy rains. An analysis for available calcium at depths of 4, 8, 12, and 18 inches indicated that there was in fact some movement. It is of interest that some strontium-90 did move through the soil under these conditions, as was shown by depthwise assay of soil cores

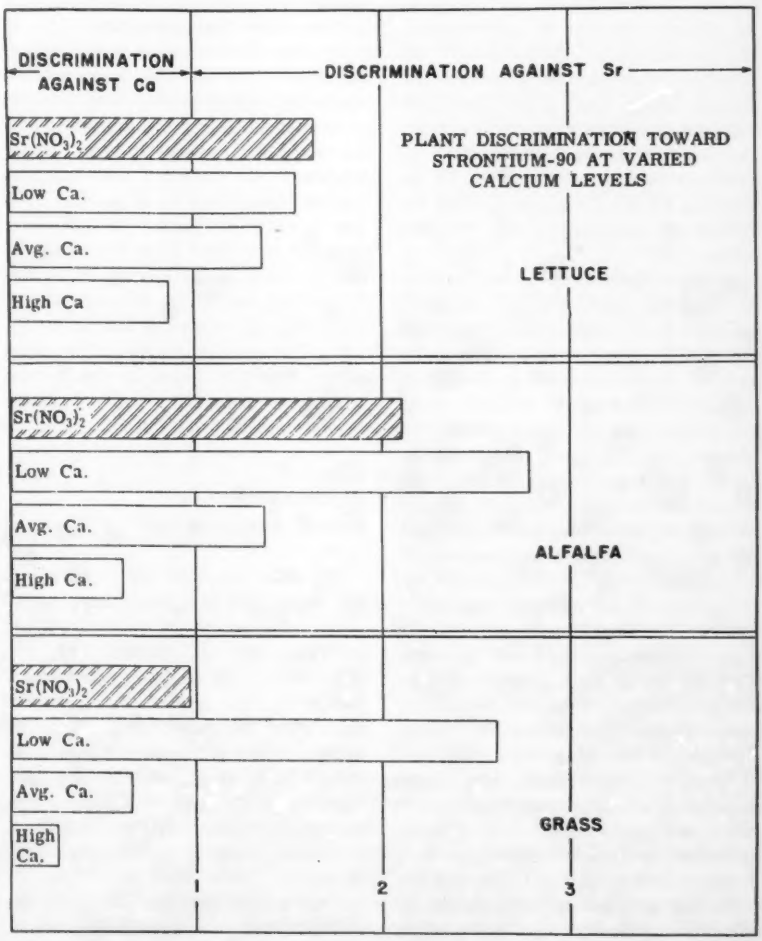

Fig. 2. Discrimination against strontium-90 in lettuce, alfalfa, and grass at various concentrations of calcium.

from plots to which a surface spike had been applied. However, attempts to repeat these results in the laboratory on 1-inch soil columns of varied length did not show a pattern of movement similar to that obtained in the field. Data indicate that high calcium in the soil increases the rate of leaching of strontium.

The ratio of strontium-90 to calcium in the plants from the third cutting plotted against the soil calcium found gave curves having the same general slope as those in Fig. 1, with the first increments of calcium again having the most marked depressing effect on the uptake of strontium-90. The observed movement of calcium at the time of the third cutting and the effect of high soil calcium on the movement of strontium-90 are of interest from the standpoint of fallout movement in soils. Because the movement of both calcium and strontium through the soils *after* the second cutting made calculations difficult, data obtained from the third cutting analyses are not included in the results or conclusions regarding the depressing effect of soil calcium on the uptake of strontium-90 by the three crops.

A greater reduction of soil calcium by leaching shortly before the third cutting was observed under lettuce than under grass. Such a relationship to the rate of water penetration would be expected. Leaching of calcium under the three types of cover follows the pattern: under grass < under alfalfa < under lettuce. Hence, both the concentration of soil calcium and the type of cover may affect the depth of penetration of the strontium-90. Other factors of importance in the movement of strontium-90 downward through the soil would include the exchange capacity of the soil for strontium-90, the soil *p*H, and the type of soil colloid. An attempt was made in this work to hold these factors constant through the use of a single soil type.

Libby (*3*) states that a lack of detailed correlation between strontium-90 in the soil and in alfalfa from samples collected on 11 midwestern farms is probably due to direct fallout on the plant. Libby's data do not indicate the calcium content of the soil upon which alfalfa was grown or the age of the plant. It is possible that alfalfa containing low concentrations of strontium-90 was harvested from old plants which were deep-feeding and, hence, contained a low concentration of strontium-90. Foliar absorption indeed plays an important role in concentration of strontium-90 in plants; however, the erratic concentration of strontium-90 observed by Libby might be accounted for in part by soil calcium concentration or depth of feeding and not entirely by foliar absorption.

Conclusions

1) The adsorption of strontium-90 by lettuce, grass, and alfalfa is progessively inhibited by increasing concentrations of soil calcium.

2) The inhibition is more marked in the case of lettuce and grass than in the case of alfalfa.

3) Lettuce and alfalfa apparently discriminate against strontium to a greater extent than does grass.

4) The discrimination noted against strontium (up to 2.8) is dependent upon the concentration of soil calcium.

5) Cesium-137 is removed by plants from soil to a lesser degree than is strontium-90. Apparent discrimination against cesium may be as great as 1100 and is dependent upon soil potassium and soil type. This high value may be due, in part, to the binding of cesium by the soil and to the consequent nonavailability of cesium to the plant (*9*).

6) The depth of feeding of the plant is an important factor in the natural adsorption from the soil of radionuclides arising from fallout.

Determination of the Over-all Ratio in Man

The determinations for a discrimination factor for or against strontium-90 as described in this article and reported by Libby (*3*) and Menzel (*13*) are quite close (1.0 to 1.4 against strontium-90), if one assumes that the strontium-90 in the bomb debris used by Menzel is only 50 percent available to the plant. However, we feel that these figures are of little or no value for determining the over-all ratio of strontium-90/calcium in soil to strontium-90/calcium in bone.

The reasons for this statement are fourfold. First, the root-feeding zone is, in all probability, much deeper than the strontium-90, which has been reported to be almost entirely in the top 2½ inches of soil. This factor is further complicated by the fact that root depth varies from 1 foot to more than 20 feet, according to the type and age of the plant in question. For example, the discrimination against strontium-90 was shown to be 1.5 in the case of alfalfa grown in a tank in which the strontium-90 was uniformly mixed with the soil. For alfalfa grown in a comparable tank with the strontium-90 added as a surface spike, the figure, calculated on the basis of the concentration of strontium-90 in the top 4 inches of soil, becomes 8.2. Second, it has been demonstrated that the soil calcium markedly affects the uptake of strontium-90, and this factor also varies over an extremely wide range. Third, foliar absorption perhaps plays an important though unknown role. This would be particularly true of deep-rooted plants, such as alfalfa, which feed largely in an area free of strontium-90. Much work remains to be done on this phase of the study. Fourth, specific land areas necessarily have a marked effect on the amount of strontium-90 taken up by a plant. Libby points out that arid regions will have little fallout and hence, very little foliar absorption, and that if the plants are irrigated, the irrigation water will contain little strontium-90, since much of the nuclide will have been previously adsorbed on soils contacted at the time of runoff.

It is quite apparent from the foregoing discussion that any determination of the over-all ratio from soils is going to be fraught with difficulties. It is entirely possible that average plants might better be used than soils as a base for determination of the over-all ratio, and it is becoming increasingly apparent that no matter how the over-all ratio is determined, one will be extremely fortunate to determine it within an order of magnitude (*14*).

Added Comments

A report of the 1957 hearings before the Joint Committee on Atomic Energy (*15*) has been published since completion of the work described above. The four factors presented here were discussed at some length by the committee and the attending scientists.

Since this work was first reported several other reports have appeared in the literature. They are briefly reviewed here.

Middleton (*16*) has pointed out that foliar absorption of cesium-137 and strontium-90 takes place to varying degrees according to the stage of maturity

of the plant and the plant type. In the case of wheat, rainfall may remove as much as 85 percent of the applied isotope. In all cases, the higher percentage of applied strontium-90 was found to be associated with the leaves and stems of the plant.

Prout (*17*) has indicated the effect of *p*H and concentration on the ion-exchange capacity of a particular soil for strontium. Absorption reached a maximum at *p*H 7.0 and at lower concentrations of strontium. He has also indicated a decrease in absorptive capacity with increase in salt concentration. We had pointed out previously (*18*) the inverse of this reaction—that is, the desorption of strontium from tuff and soils by various salt solutions.

Nishita *et al.* (*11*), in an excellent study, have shown a utilization of non-exchangeable potassium by Ladino clover. They also point out that, as exchangeable potassium decreases in the soil, the amount of cesium-137 fixed by the soil increases. Evidence is presented for increased cesium-137 uptake as exchangeable soil potassium decreases due to continued cropping.

Romney *et al.* (*10*) have shown that stable strontium releases strontium-90 to the soil solution so that strontium-90 becomes more available to the plant up to applications of about 5 tons of strontium per acre. No practical dilution effect of strontium-90 by stable strontium was shown.

Romney *et al.* (*8*) have studied the uptake of strontium-90 and four other radioisotopes by five different plants from seven different soils. Strontium-90 was very significantly taken up by all plants. Both plant and soil effects were noted. These authors also point out an inverse relationship between strontium-90 in the plant and available calcium in the soil.

Klechkovsky (*5*) has reviewed extensively the work on behavior of fission products in soil in the U.S.S.R. He also points out the lack of cesium-137 uptake from soil by plants and notes an inverse relationship between concentrations of calcium in soil and of strontium-90 in plants. Of interest is his report of marked increase in the uptake of cesium-137 when plants are grown hydroponically. These results further indicate nonavailability of soil cesium and are attributed to the strong bond between cesium and the soil colloid.

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Gilbert Morgan Smith, Botanist

Unlike many scientists, Gilbert Morgan Smith, who was born in Beloit, Wisconsin, 6 January 1885, gave no indication of his future occupation in his boyhood hobbies and activities. Indeed, despite the fact that he came from an academic family—his father, Erastus Gilbert Smith, was professor of chemistry at Beloit College—Gilbert's career as a scholar began inauspiciously. He had difficulty with his studies (particularly the classics), and his pranks at Beloit High School were far more memorable than his academic record. Many of the present generation of botanists who were brought up on the two volumes of the scholarly *Cryptogamic Botany* will be shocked to learn that its author was almost expelled from high school for putting asafetida in the heating ducts. Through the influence of his father, he was accepted at Williston Academy, where the perceptive headmaster soon discovered his aptitude for science. From that time on, his progress was so rapid that his undergraduate record qualified him for election to Phi Beta Kappa when a chapter was established at Beloit.

After graduating from Beloit College in 1907, he taught science in high school in Stoughton, Wis., for a year before he began graduate study at the University of Wisconsin. He had intended to become a chemist, but while preparing for language examinations he became so fascinated with the algae that he decided to work in botany under C. E. Allen. He obtained his Ph.D. in 1913 and was married that same year to Helen Pfuderer, who shared his career from that time on. He remained on the staff at Wisconsin and moved steadily upward in academic rank. In 1923 he was invited to Stanford University for the autumn quarter, and two years later he succeeded Douglas Houghton Campbell as professor of botany at Stanford. He became emeritus professor of biology (botany) in 1950 but remained active scientifically until he died, on 11 July 1959.

Smith was accorded many honors. He was elected to the National Academy, the American Academy, Phi Beta Kappa, Beta Theta Pi, and Sigma Xi. Beloit College recognized his ability

Gilbert Morgan Smith (left) and Professor F. E. Fritsch, Stockholm, 1950.

relatively early by awarding him an honorary D.Sc. in 1927. Although he scorned the biological "politician," his ability and reputation were such that he was elected to office in a number of scientific societies. He served as president of the Botanical Society of America, the American Microscopical Society, the Phycological Society of America, and section G of the AAAS.

Although Smith considered himself to be a morphologist, he contributed to many phases of phycology. His interests developed in a logical sequence, from the detailed cytological and developmental studies which formed the basis of his doctoral thesis, to the extensive surveys of the phytoplankton of the lakes of Wisconsin and other regions, to the studies of marine algae after his move to California, and finally to his physiological studies on sexual reproduction in *Chlamydomonas*. In the years immediately preceding his death he demonstrated that sexual reproduction in this small green alga is coordinated by at least two substances—one that is heat-labile and extracellular and one that is intracellular. It is most unfortunate that he was unable to bring these studies to completion for publication, but his notebooks describing his experiments will be on file at Stanford, together with his outstanding collection of reprints on algae, which his wife has given the library.

Smith's books were a logical outgrowth of his research and teaching. His participation in the elementary botany course at Wisconsin made logical his leadership in the writing of *A Textbook of General Botany*, which has gone through five editions and numerous printings. His *Fresh-water Algae of the United States*, a comprehensive and useful manual which met with acclaim on both sides of the Atlantic, was a natural outgrowth of his familiarity with fresh-water algae, gained through his surveys of phytoplankton. The *Marine Algae of the Monterey Peninsula* was based on his years of teaching a summer course at the Hopkins Marine Station. Finally, his best-known work, *Cryptogamic Botany*, was a summation of his experience with both fresh-water and marine algae and of that gained from teaching the courses in mosses and ferns which he inherited from his predecessor.

Smith's success as an author must be attributed in large part to the clarity of his thinking. He thought in paragraphs. When he was writing he pecked out manuscript steadily on his portable typewriter. He did his library work in advance and kept meticulous running files on various topics, so that he seldom paused to look up material. His writing style was straightforward; he wasted no time casting about for elegant words or colorful expressions. His illustrations were drawn in the same forthright manner.

The same careful preparation and clarity of expression which characterized Smith's writing made him an excellent lecturer. He lectured slowly but without repetition, and in advanced courses he covered a great deal of material. In elementary courses, he believed in simplification by omitting topics rather than by diluting them. "The most important thing in teaching an elementary course," he used to say jokingly, "is learning to suppress the truth." In his advanced courses he suppressed very little. He did not indulge in the stereotyped classroom joke which is designed to elicit uproarious laughter from a captive audience, but his lectures were laced with a subtle humor—"the chloroplast of *Chlamydomonas* is shaped like a cup—a cup in a drive-in restaurant, because the bottom is very thick," or "the zoospore of *Oedogonium* is like toast—it always lands buttered side down." On occasion he could be dramatic, as when he bolted from the classroom shouting "follow me" over his shoulder. The bewildered class followed him through corridors and passageways to a laboratory which had Venetian blinds. Smith seized the controls, and working them back and forth vigorously, said, "See, incubous . . . succubous . . . incubous . . . succubous." At least one class should remember these vexing adjectives, which describe the arrangement of liverwort "leaves."

Perhaps one of Smith's outstanding characteristics was his extraordinary self-discipline. It was this—in addition to his efficiency and energy—that made his great output possible. After the early days at Wisconsin, his routine followed an invariable pattern. He arrived at his office shortly after 8:00 and wrote or made observations steadily until about 10:30, when he took a short break (about long enough to smoke half a cigarette), during which he stretched his legs or talked with colleagues. He then worked steadily until noon, ate lunch, and returned to work until about 3:30, when he took another break; after this he worked on until about 5:30. On Wednesday afternoons he played golf. He never took work home, and he never returned to the laboratory in the evening. In the evening, he engaged in an active social life. From 8:00 to 5:00 he was a dedicated scientist whose manner was such as to discourage the garrulous; from 5:00 to 8:00 he was an excellent bridge player, an accomplished dancer, and a gifted conversationalist. His colleagues at the University rarely saw him at play; the

friends whom he knew socially had little idea of his prominence as a scientist.

Smith resembled his predecessor, D. H. Campbell, in his love of travel. From the North Cape in 1920 to Indonesia in 1956, he and his wife covered most of the globe, with the exception of the interior of Asia, the eastern Mediterranean, and Antarctica. His reputation and his wide correspondence made him a welcome visitor to botanical laboratories everywhere.

As his health deteriorated during the last two years, Smith's courage was an inspiration. For one accustomed to relying on himself, physical weakness must have been more difficult to bear than pain, yet he continued to come to his laboratory despite the great effort involved, and during his last days, when he was able to speak only with difficulty, he continued to direct the activities of his assistant from his hospital bed. The passing of such a man leaves a void that can never be filled by a research team.

ROBERT M. PAGE
Department of Biological Sciences, Stanford University, California

Science in the News

Permanent Space Committee Established by United Nations

The United Nations General Assembly approved on 12 December the establishment of a permanent Committee for International Cooperation in the Peaceful Uses of Outer Space. The new committee was set up as the result of a resolution passed earlier in the day by the U.N. Political Committee. The vote was 74 to 0; the Dominican Republic abstained, and seven members of the committee were absent.

Functions Described

The Political Committee proposal to the General Assembly stated that the space committee's responsibilities would be to:

"(A) Revise, as appropriate, the area of international cooperation, and study practical and feasible means for giving effect to programs in the peaceful uses of outer space which could appropriately be undertaken under United Nations auspices, including *inter alia*: (i) assistance for continuation on a permanent basis of the outer space research carried on within the framework of the International Geophysical Year; (ii) organization of the mutual exchange and dissemination of information on outer space research; and (iii) encouragement of national research programs for the study of outer space, and the rendering of all possible assistance and help towards their realization.

"(B) Study the nature of legal problems which may arise from exploration of outer space."

The permanent body will not take up the regulation of the military uses of outer space. Neither the United States nor the Soviet Union is willing to have it do so.

Membership Balance Controversial

The East-West balance of membership on the committee has long been a controversial issue. A temporary space committee was established a year ago, but it could not be effective because it was boycotted by the Soviet Union. The temporary body had 12 Western members, three neutral (Sweden, India, and the United Arab Republic), and three members of the Soviet bloc (the U.S.S.R., Poland, and Czechoslovakia). Two of the neutral members, India and the United Arab Republic, refused to participate in committee activities last spring because of the Soviet boycott.

During the negotiations in recent weeks several of the Western delegates indicated that their governments would not agree to more than five seats for the Soviet bloc on the permanent committee. They held that even this number was too many, since it was disproportionate to the strength of the Soviet bloc in the United Nations. The Soviet bloc has nine members out of 82.

The new 24-member space committee is composed of 12 countries that are members of joint defense agreements against possible Soviet aggression, seven members of the Soviet bloc, and five neutral countries. The members follow: Albania, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Czechoslovakia, France, Hungary, India, Iran, Italy, Japan, Lebanon, Mexico, Poland, Romania, Sweden, the U.S.S.R., the United Arab Republic, the United Kingdom, and the United States.

The Political Committee's space proposals to the General Assembly included a resolution calling for an international conference in 1960 or 1961 "for the exchange of experience in the peaceful uses of outer space." Participation is limited to members of the United Nations and its specialized agencies.

The U.N. does not plan to establish any new permanent agency to administer the outer-space program, as it did for atoms-for-peace. Instead, the program will operate through COSPAR, a body that was set up in October 1958 within the framework of the International Council of Scientific Unions to continue the cooperation and exchange of data in space research that had developed during the International Geophysical Year. The national adherents to COSPAR are scientific academies, not governments.

Geological Survey Volcanologists Study New Series of Eruptions at Hawaii's Kilauea

New eruptions of the volcano Kilauea in Hawaii are being studied by the staff of the U.S. Geological Survey's Hawaiian Volcano Observatory, which is located in Hawaii National Park on the rim of Kilauea. Surface activity thus far has been limited to a portion of the crater called Kilauea Iki or "Little Kilauea." Between 14 November and 5 December Iki erupted five times, its lava fountain rising to a height of 1650 feet or more and dying abruptly after

(Top) Jerry Eaton, geophysicist, Wayne Ault, chemist, and Kiguma J. Murata, scientist in charge, sampling hot gases on the first stage cone in Kilauea Iki. Note the gas-sampling bulbs and the improvised protection against choking vapors. (Bottom) View of the fountain, 600 to 900 feet high, from Byron's Ledge (a narrow separation between the main crater and Kilauea Iki). Lava in the lake is approaching the level of the fountain.

varying periods of time. The first phase of activity lasted for a week, but in the fifth phase the fountain, which reached a temperature of 2170°F, subsided after only 9½ hours.

Lava Forms Lake

The main bulk of the erupting lava flows first northwestward to a high-level pond, then eastward to the main floor of the Kilauea Iki pit. During the first phase the rate of delivery was estimated at about 50 cubic yards per second. Pegs driven into the side of Kilauea Iki's main pit on 17 November to keep track of the level of the lava pond, which is about 35 acres in area, disclosed a rise of 25 feet overnight; by 20 November the level was rising at a rate of 4 feet per hour. On 21 November, the pond reached a depth of 350 feet, forming a fiery lake estimated to contain 40 million cubic yards of material.

During each event a vast amount of lava, perhaps as much as 10 million cubic yards, flows back into the vent. However, there is a net gain in the amount of lava in the pond after every phase of activity. Calculations are not yet complete, but Survey scientists have arrived at an approximate figure of 55 million cubic yards for the net output to date.

Seismologic instrumentation and tiltmeters have made it possible to follow the course of the current activity ever since its beginning several months ago at a depth of approximately 36 miles. When in mid-October small, shallow earthquakes were being recorded at a rate of several hundred a day at a single observation station, extra manpower was called into action to keep a close watch on the network of tiltmeter stations.

Tiltmeters record bulges and subsidences on the surface that would not otherwise be noticeable. Ordinarily, a continually rising bulge (like the one that preceded the eruption of Kilauea in 1955) is a prelude to an eruption of lava surging upward from depth. However, the activity does not always reach the surface because rising lava may be drained off laterally into quiet rift zones capable of containing an entire flow. After the period of upwelling, the volcano contracts and the slopes tilt inward.

The Survey Team's Work

The Survey's observation program is headed by Jack Murata, who has been

submitting regular reports to Washington. Members of the Hawaii staff have been working all hours of the day and night on their special projects since the period of intense activity began. They meet early every morning for a conference, discuss their observations, determine what should be done next, establish a plan of action for the day, and then leave for the crater. Duties change from day to day as new objectives are indicated.

Increased heat radiation, strong gas emission, and smoke from burning trees are making the work difficult. However, unlike Kilauea's principal fire pit, which is lined by vertical walls, Kilauea Iki can be entered without too much difficulty. So far the eruptions have been confined to the crater, so that there is no danger yet to the surrounding area and buildings.

In addition to keeping continuous seismological and tiltmeter records, the staff members are performing certain tasks like lava collection and gas sampling on a regular basis. A series of gravity surveys is also being launched, and a network of gravimeter stations has just been established to study the changes in the force of gravity as the lava shifts underground.

Tentative Findings Reported

Early this month Murata reported that a rough correlation seems to exist between the olivine content and the temperature of the erupted material. The iron-magnesium mineral olivine apparently sinks rapidly in the magma so that a strong flushing action from deep down is required to bring it to the surface. It is during such periods of strong flow from depth that the highest temperatures can be expected.

During periods dominated by the formation of pumice, temperatures appear to be lower. There have been two periods of pumice eruption and two of picrite eruption; this suggests that the activity has a cycle pattern that is independent of the timing of the individual phases. (Picrite is a lava of high olivine content.)

Crater Rim Road, which is to leeward of the Kilauea Iki vent, is now buried under 100 feet of pumice, and more is accumulating. During the periods of pumice eruption, only a minor amount of lava runs from the vent and spreads slowly out over the chilled surface of the lava pond.

Murata has also reported that an analysis in mid-November of a sample of fresh lava showed it to be 49.5 percent silica, indicating, he said, that the magma was "definitely more primitive than anything that came out during the 1955 eruption." The primitive composition correlates with the rising temperatures measured. Jack Murata commented:

"This is a case of very rapid delivery of undifferentiated material to the surface. Our group had developed a concept of the effect of speed of ascent and cooling of the magma on the composition of the lavas, and this eruption seems to bear us out."

The long-range objective of the Hawaiian observatory's program is to learn enough about the geochemistry and geophysics of volcanos to be able to accurately predict eruptions, thus lessening destruction of human life and property. Since seismological tremors are continuing at Kilauea, termination of the present unusually interesting series of eruptions is not in sight.

Scientific Sections of Exchange Agreement with Soviet Union

On 21 November in Moscow the United States and the U.S.S.R. signed an agreement for cooperaton in exchanges in the scientific, technical, and cultural fields in 1960–61. The agreement included as an addendum the text of the Memorandum on Cooperation in the Field of the Utilization of Atomic Energy for Peaceful Purposes, which was signed in Washington, D.C., on 20 November [*Science* **130** *(4 Dec. 1959)*]. *Abstracts from the text of the new exchange program follow.*

Section II. Scientific Exchanges

1) The two parties, attaching great significance to the development of scientific exchanges between both countries, will take all appropriate measures in order to achieve fulfillment of the agreement for exchanges in the field of science concluded July 9, 1959, between the Academy of Sciences of the U.S.S.R. and the National Academy of Sciences of the U.S.A.

2) Additional visits by scientists of one country to the other country may also be agreed upon through diplomatic channels or between appropriate organizations as approved by each party.

Such visits, whether for the purpose of participating in scientific meetings, exchanges of experience, conducting studies, or delivering lectures shall take place on a basis of reciprocity.

3) Cooperation in the field of utilization of atomic energy for peaceful purposes. Both parties agree that in the field of the peaceful uses of atomic energy they will provide for reciprocal exchanges of information and visits of scientists and will explore the desirability of joint projects. To that end, specific proposals will be developed between the United States Atomic Energy Commission and the Main Administration for the Utilization of Atomic Energy under the Council of Ministers of the U.S.S.R. which will be subject to approval by the two governments in the usual manner, and which may be appended to this agreement as an addendum.

4) Both parties are in favor of having the Academy of Sciences of the U.S.S.R. and the American Council of Learned Societies come to an agreement on exchanges, on a reciprocal basis, of scholars in the social sciences and the humanities, such as historians, economists, philosophers, specialists in literature, and linguistics.

Both parties are in favor of having the Academy of Sciences of the U.S.S.R. and the American Council of Learned Societies provide for participation, on a reciprocal basis, by scholars of both countries in joint seminars and symposia and consider joint research projects.

5) Both parties agree to provide for an exchange of delegations of geographers of four to six persons for three to four weeks, with a program to be agreed upon by appropriate organizations. . . .

Section IV. Exchanges in the Field of Agriculture

1) Both parties will provide for an exchange of delegations of specialists in agriculture, consisting of three to six persons each, for a period of three to four weeks, in specific fields as follows:

Soviet Delegations to the U.S. (a) Food processing (meats, grains, and canning crops). (Number of persons in the delegation as previously agreed upon.) (b) Fertilizers, insecticides, and weed killers. (c) Poultry-husbandry, study of broiler production and methods of hybridization. (d) Agricultural science and information. (e) The breeding and hybridization of cattle and pigs. (f) Complex mechanization of cultivation and harvesting of sugar beets and potatoes.

U.S. Delegations to the U.S.S.R. (a)

Handling, storage, and transportation of grain. (b) Food processing. (c) Agricultural information and planning. (d) Soil salinity. (e) Poultry-husbandry. (f) Forage crops and range management.

2) Both parties will continue to exchange appropriate films dealing with the subject of agriculture.

Section V. Educational Exchanges

1) Both parties agree to provide for the exchange of students, postgraduate students, and young instructors or researchers between Soviet universities and other institutions of higher learning on the one hand and American universities and other institutions of higher learning on the other, of up to 35 persons on each side for the academic year 1960–61 and up to 50 persons for the academic year 1961–62. These exchanges will be carried out according to the annex to this section on the basis of appropriate subsequent agreement between the educational authorities of both parties, including the precise number of students and financial and other conditions. The educational authorities of each receiving side will undertake on the basis of reciprocity to place the students in scholarly institutions (including universities or other institutions of higher learning) appropriate to the specialty or scientific subject selected by them and to their scholarly attainments as required under paragraph 4 of the annex to this section.

2) The term "student" as used hereafter in this section of the agreement and in the annex shall be taken also to include postgraduate students and young instructors or researchers. Composition of student groups shall be determined by the sending side.

3) The regular period of sojourn in the host country for students identified by this agreement shall be ten months. Shorter or longer periods of sojourn (five to 15 months) may be provided for by prior agreement between the educational authorities on each side without effect on the total number of academic man-years specified.

4) Further concrete details will be worked out by means of direct negotiations between representatives of both parties in the field of education.

5) The appropriate educational authorities of each party will conduct negotiations prior to February 1, 1960, regarding the arrangement in their respective countries of study courses in English and Russian languages, to which each party will send up to 25 students, who may be accompanied by one or two language specialists, for sojourn in the country of up to 12 weeks during the period June–September.

If they do not come to an agreement prior to February 1, 1960, this exchange may be considered for 1961. If the exchange takes place in 1960, it may be repeated in 1961 by agreement between the appropriate educational authorities.

6) The United States side will arrange to invite Soviet teachers of the Russian language to the United States in the academic year 1960–61 to occupy positions in American universities for teaching the Russian language. Arrangements with respect to positions to be occupied by Soviet teachers, transportation expenses, salaries, lodging, and academic benefits as enjoyed by their American colleagues of similar standing will be the subject of negotiation between the appropriate institutions of each party. The Soviet side will undertake to make similar arrangements to invite American teachers of English to Soviet universities.

7) Both parties agree to provide for exchanges in the years 1960–61 of professors, teachers, and researchers in the approximate number of five persons each year from each university; the exchanges will take place between the following institutions: Moscow and Columbia Universities, Leningrad and Harvard, Kiev and Yale, Indiana and Tashkent. The duration of the visits and the conditions of the exchanges will be determined by agreement between the afore-mentioned universities. Nothing in this paragraph excludes the conclusion of additional agreements between American universities and colleges and Soviet universities and other institutions of higher learning.

8) Both parties agree to provide for the following exchanges of specialists in education in the years 1960–61.

(a) Two delegations comprising five to six persons each for 20 to 30 days to study technical education and preparation of qualified workers in machine building, ore mining, and food industry in establishments for public services. The United States delegations will represent the American Association of Junior Colleges and the Engineers Joint Council and will be interested in aspects of technical education in U.S.S.R. The Soviet delegations will study training of skilled labor in afore-mentioned fields and, if they desire, may also study American technical education in general.

(b) One delegation comprising two to three persons from each side for a period of three to four weeks to study organization, sources, and techniques of conducting educational research (spring 1960).

(c) One delegation of three persons from each side for a period of three to four weeks to study methods and results in teaching of foreign languages (English, Russian, and other Western as well as Eastern languages) at the primary and secondary schools as well as teacher-college and university levels (spring 1960).

(d) The Soviet side will receive one American delegation of two to three persons for four weeks to study education in arts (choreography, music, painting, graphics, plastic art, etc.) at different levels. They will visit schools and out-of-school institutions (spring 1960).

The American side will receive one Soviet delegation of two to three persons for four weeks to study school construction and the production of training equipment for schools.

(e) One delegation from each side comprising five to seven persons for up to four weeks between the American Library Association and appropriate Soviet organizations to visit libraries and bibliographic centers and also to study (i) bibliographic techniques, compilation of indices and other techniques of library documentation and analogous processes; (ii) methods of reproduction and dissemination, including the operation of specialized libraries and centers; and (iii) methods of training library personnel, establishment of the level and organization of technical processes.

9) Both sides recognize the desirability of continuing the exchange of literature in the methodolgy of teaching, educational films, and other pedagogical materials.

Annex to Section V. Educational Exchanges

1) Both sides agree to provide access for each student to all scholarly and scientific materials necessary in his field of study on the basis of a mutually agreed study plan.

In case of necessity, this plan can, where appropriate and possible, include work in research institutions and contacts with scientists in other research institutions which are outside the system of higher education establishments.

2) Both sides agree to provide for living quarters for a wife of any married student who may desire to remain with

him during the school year; and to permit the wives of other married students at least one 30-day visit to their husbands during the school year or at its termination. The receiving side will bear no expenses for the travel or sojourn of visiting wives.

3) Each receiving side will bear, through appropriate agencies or organizations which it may select, the following expenses: tuition and fees for training in institutions of higher learning and for living quarters and monthly stipend in an amount to be subject to an agreement in advance by both sides.

In the case of a student's illness or accident, the receiving side will bear all medical costs, including hospital expenses, within limits established by each side.

All other expenses including travel to the country, to the place of study within the country, and return to the home country at the end of the school year will be borne by the sending side with the exception of situations to be mutually agreed upon in advance.

4) The sending side will submit to the appropriate educational authorities of the receiving side at least five months before the beginning of the academic year a list of its students together with information on the course of study of each student.

Notification of final acceptances and placement of the students must be given at least two months before the beginning of the academic year.

5) Each side may send, at its expense, its representatives to the host country to familiarize themselves with the conditions of study and sojourn of their students.

Section VI. Cooperation in the Field of Public Health and Medical Sciences

1) Both parties affirm their interest in intensifying the struggle against serious diseases which are the enemy of all mankind. As a step toward the achievement of this goal both parties will make efforts to put into effect the agreed program for cooperation in public health and medical science, which for the years 1960–61 contemplates, in particular, the measures described below.

Details of specific exchanges will be agreed upon by direct negotiations between the U.S.S.R. Ministry of Health and the U.S. Public Health Service.

2) The U.S.S.R. Ministry of Health and the U.S. Public Health Service will facilitate cooperation between scientific-research institutes of the U.S.S.R. and corresponding governmental, and the below-specified and other mutually agreed upon non-governmental, research organizations of the United States conducting studies on the problems of cancer, cardiovascular illnesses, poliomyelitis, and on other important problems of medicine.

First of all both parties will facilitate the establishment and development of contacts and cooperation between the following Soviet and American scientific institutions: (a) For the Soviet side, the Institute of Experimental and Clinical Oncology, Academy of Medical Sciences of the U.S.S.R., and for the U.S. side, the Sloan-Kettering Institute and National Cancer Institute. (b) For the Soviet side, the Institute of Therapy, Academy of Medical Sciences of the U.S.S.R. and, through it, other Soviet scientific institutions engaged in the study of cardiovascular diseases; and, for the U.S. side, the National Heart Institute and, through it, other American scientific institutions engaged in the study of cardiovascular diseases. (c) For the Soviet side, the Institute for the Study of Poliomyelitis, Academy of Medical Sciences of the U.S.S.R., and, for the U.S. side, the Research Foundation, Children's Hospital, Cincinnati, and the National Institutes of Health (Division of Biological Standards).

The afore-mentioned organizations shall be encouraged by both parties to exchange plans of scientific-research work and information about research conducted, to organize joint scientific studies, to exchange specialists, and to participate in yearly joint scientific meetings which shall be convened by the afore-mentioned institutes, or the U.S.S.R. Ministry of Health, or the U.S. Public Health Service, alternately in the U.S. and the U.S.S.R.

In 1960 such meetings shall take place at the Sloan-Kettering Institute (U.S.A.), the National Heart Institute (U.S.A.), and the Institute for the Study of Poliomyelitis, U.S.S.R. Academy of Medical Sciences.

3) Both parties shall facilitate an exchange of high-level specialists and junior scientific workers, numbering up to 20 persons on each side, for a period of up to one year on the basis of general reciprocity for familiarization with the work of scientific-research institutes and establishments of the U.S.S.R. and U.S.A. enumerated in paragraph 2 of the present section, and also other scientific establishments of both parties for the exchange of experience, or for the conduct of jointly agreed upon research.

Scientists sent to the yearly joint scientific meetings of the institutes conducted in accordance with paragraph 2 and members of delegations provided for in paragraph 4 of this section of the agreement are not included in the above specified number (20 persons).

4) Both parties will provide for an exchange in 1960–61 of five delegations of three to six persons each for a period of three to four weeks.

Delegations of the Soviet Union will study the following subjects in the U.S.A.: (a) malignant neoplasms (etiology, pathogenesis, and the therapy of tumors), and also biochemical and histochemical research on tumors; (b) the pathology of cardiovascular systems (hypertension, atherosclerosis, coronary insufficiency); (c) thoracic surgery (cardiology, artificial circulation of the blood); (d) virology (the genetics of viruses); (e) industrial medicine and hygiene (organization of scientific research on labor hygiene and occupational diseases, familiarization with scientific research on important problems of labor hygiene such as silicosis, industrial toxicology, physiology of labor, and occupational disease).

U.S. delegations will study the following subjects in the U.S.S.R.: (a) infectious diseases and microbiology; (b) neurophysiology and pathology; (c) metabolism and genetics; (d) medical ecology; (e) maternal and child care and related research.

5) The local expenses of specialists, including internal travel, involved in the exchanges covered in this section shall, except as otherwise agreed in specific cases by the U.S.S.R. Ministry of Health and the U.S. Public Health Service, be met in the case of visits not exceeding six weeks by the sending side and in the case of visits exceeding six weeks by the receiving side, on terms to be agreed upon in each case between the U.S.S.R. Ministry of Health and the U.S. Public Health Service.

6) Both parties shall facilitate the publication of works on the most important problems of medical science by American research workers in Soviet medical journals and by Soviet research workers in American medical journals.

7) Both parties shall facilitate the further development of exchanges of medical journals and books between Soviet and American libraries and institutions, as well as the exchange of medical films.

8) Both parties agree to inform the World Health Organization of the activities carried out under this section of this agreement. . . .

Section X. Exchange of Publications

1) Both parties, having exchanged their views on the problems of distributing the magazines *Amerika* in the Soviet Union and *U.S.S.R.* in the United States, have agreed on the desirability of facilitating the distribution of these magazines on the basis of reciprocity. Examination of measures taken by both parties to achieve this end will continue, with the aim of increasing the distribution of these magazines to 77,000 copies each.

2) Both parties agree to assist in the exchange of books, magazines, and other publications devoted to scientific, cultural, technical, and educational subjects by encouraging exchanges of books and publications between universities and public libraries of the U.S. and U.S.S.R.

Section XI. Exchange of Exhibitions

1) Both parties will provide for the exchange of exhibitions during 1960–61.

Soviet exhibitions in the U.S.A.: (a) medicine and medical services; (b) children's books and illustrations; (c) children's artistic and technical work (drawings, models, and toys made by children).

United States exhibits in the U.S.S.R.: (a) medicine and medical services; (b) plastics; (c) transport.

2) Other exhibitions, as well as participation in internation exhibitions which take place in each country during 1960–61, will be determined by mutual agreement. The parties will likewise discuss in the near future the possibility of exchanging national exhibitions in subsequent years.

Radioactive Waste Disposal Discussed in Monaco

A week of discussions at the international conference in Monaco on the disposal of radioactive waste ended on 21 November on a note of general agreement that whatever methods of disposal are chosen, they must have the overriding aim of not endangering man either immediately or in the long run. This view was summed up in a closing speech by G. W. C. Tait, director of the Division of Health, Safety, and Waste Disposal of the International Atomic Energy Agency, which had organized the conference jointly with UNESCO and in cooperation with the Food and Agriculture Organization. The conference was attended by 308 specialists from 32 countries and 11 international organizations.

The meeting opened on 16 November with a speech by the IAEA director general, Sterling Cole, who emphasized that the problem of radioactive waste was really one of storage rather than of disposal. Even if there is no ready use for this material now, he said, this does not mean that a use will not be found in the course of time.

In the papers presented at the conference and in the course of the discussions that followed, the problem of waste disposal was discussed from all the major practical and theoretical points of view. Some scientists gave an indication of the amount of the wastes now being produced or likely to be produced in the future. For example, an American scientist stated that in the United States alone, the nuclear power industry would have produced, by the year 2000, wastes amounting to about 3 million curies of activity.

Solutions in Various Countries

One scientist expressed the view that the normal operation of a nuclear reactor raises no great problems; the main danger lies in the operation of fuel reprocessing plants. As for the problem of atmospheric contamination, he said, the solution lies both in good design of nuclear plants, so as to limit the production of wastes, and in improved methods of cleaning the air released by these plants.

An expert from Norway, speaking of the potential suitability of the earth's atmosphere for disposal operations, said that radioactive particles remain in the stratosphere for a period long enough to allow certain substances to become harmless before they return to the earth's surface. A scientist from the Danish Atomic Energy Commission told how the Riso research establishment has constructed a decontamination plant for reducing radioactivity in liquid waste to less than one-tenth of the maximum set for drinking water. A scientist from the U.K. Atomic Energy Authority described disposal methods at Harwell, where extreme care has to be taken because low-level liquid waste is discharged after special treatment into the Thames, the main source of London's drinking water. No solid waste is buried at Harwell, because of the danger of possible seepage into the river. Methods now being tested in France for the disposal of solid wastes were described by two experts from the French Atomic Energy Commission. A Soviet scientist said that the fixation of radioactive material in glass under high temperature is being studied in the Soviet Union; this process is intended to make the material solid and to reduce its solubility before it is buried.

Several papers dealt with the legal, administrative, and other general aspects of waste disposal. Some of the experts stressed the international nature of the problem and said that existing regulations in other, similar fields might serve as models in devising international regulations for the disposal of radioactive waste.

Sea Disposal

A subject which provoked considerable discussion concerned waste disposal in the sea. A Soviet scientist said that experts in his country hold the view that no isolation of deep waters exists in the oceans. An expert on oceanography from the United States said that ten times as much money and as many facilities as are now available are needed for research on this subject; that radioactive waste is bound to get into the seas, whether one wants it or not; and that the more we find out about the circulation of radioactive elements in the oceans, the more economically we will be able to dispose of them. A Soviet scientist suggested that physicists and chemists should collaborate with oceanographers in studying the problem. Another Soviet expert maintained that disposal in the ground is the safest method available today: that the material should be enclosed in solid blocks of concrete or glass and stored at appropriate depths and under the permanent control of human beings.

News Briefs

The History of Science Society will meet in Chicago, 29–30 December, at the Congress Hotel, in cooperation with the American Historical Association. A broad program has been arranged by the officers of the History of Science Society, under the direction of Henry Guerlac, president of the society and professor of the history of medicine at Cornell University. The program will include a business meeting of the society, as well as a business meeting of the George Sarton Memorial Foundation. The latter, a nonprofit institution,

has been established to seek funds to promote the study of the history of science in American colleges and universities through lectureships and fellowships, as well as through publication of material relating to the history of science.

* * *

Some 80 U.S. laboratories and industrial firms are contributing to the United States exhibit at the First World Agricultural Fair that opened in New Delhi, India, on 11 December. The fair, which will continue through 14 February 1960, is probably the largest agricultural exhibit ever held. The estimated cost to the U.S. government for participation in the event is $2 million; rupees acquired by this country through the sale to India of U.S. farm commodities will cover a large part of these costs. Fifteen foreign nations are exhibiting at the fair.

* * *

The American Institute of Physics, 335 East 45 St., New York 17, N.Y., has announced publication of the *Journal of Mathematical Physics*, a bimonthly devoted to new mathematical methods for the solution of physical problems and to original research in physics furthered by such methods. The first issue will be dated January-February 1960.

Grants, Fellowships and Awards

Psychometrics. The Educational Testing Service is offering for 1960–61 two fellowships in psychometrics leading to the Ph.D. degree at Princeton University. These are renewable research fellowships which provide for part-time training in the general area of psychological measurement in the Princeton offices of the Educational Testing Service, in addition to the usual program of graduate studies at Princeton University.

Suitable undergraduate preparation may consist either of a major in psychology with supporting work in mathematics, or a major in mathematics with some work in psychology. However, in choosing fellows primary emphasis is given to superior scholastic attainments and research ability, rather than to specific course preparation. To be considered, a candidate must either (i) have taken the Graduate Record Examination in 1959 or (ii) register by 1 January to take these examinations on 16 January. Fellowship applications will be closed on *1 January 1960*. For information write to Harold Gulliksen, Director, Psychometric Fellowship Program, Educational Testing Service, 20 Nassau St., Princeton, N.J.

Sex. The Division of Medical Sciences of the National Academy of Sciences–National Research Council is accepting applications for grants-in-aid for research for consideration by the Committee for Research in Problems of Sex. The funds for support of this program are provided by the Rockefeller Foundation and the Ford Foundation. The committee is concerned primarily with encouraging research on the mechanisms underlying sexual behavior, with special emphasis on the higher mammals and man. Proposals involving endocrinological, neurological, psychological, anthropological, phylogenetic, and genetic studies directed toward this objective are therefore invited. Requests that deal with the physiology of reproduction or with related biological and biochemical fields should be addressed to the committee only if they give promise of shedding light upon behavioral mechanism.

Preliminary inquiries should be addressed to Room 411, Division of Medical Sciences, National Academy of Sciences–National Research Council, 2101 Constitution Ave., NW, Washington 25, D.C. Completed applications for the fiscal year 1960–61 should be postmarked on or before *15 January 1960*.

Scientists in the News

Alexander Brunschwig, attending surgeon, Memorial Center for Cancer and Allied Diseases, and professor of clinical surgery at Cornell University Medical College, New York, was one of seven scientists awarded an honorary doctorate at a special commencement on 22 November at the University of Strasbourg, France, held to commemorate the return of Alsace to France. The ceremonies were presided over by President DeGaulle.

One of the recipients of an honorary degree was **F. Staudinger**, Nobel laureate in chemistry, from Freiberg im Breisgau. This was the first time since the return of Alsace to France that the University of Strasbourg has so honored a German scholar.

Loren Eiseley, professor of anthropology and provost of the University of Pennsylvania, has received the 1959 Phi Beta Kappa Science Prize of $1000. This is the initial award of the science prize, which will be offered annually by Phi Beta Kappa for the best book published during the preceding college year on science or the interpretation of science. Eiseley earned the 1959 award for *Darwin's Century*, published by Doubleday.

George B. Kistiakowsky, special assistant to President Eisenhower for science and technology, has won the 1960 Willard Gibbs Medal of the American Chemical Society's Chicago Section. The medal will be presented on 20 May. Kistiakowsky is on leave from Harvard University, where he is professor of chemistry.

In 1944, he was chief of the explosives division of the Los Alamos Laboratory of the Manhattan District, where he prepared the explosives necessary to detonate the first atomic bomb. Kistiakowsky is widely recognized not only for his outstanding contributions to the chemistry of explosives but also for his achievements in chemical kinetics, molecular spectroscopy, and the thermodynamics of organic molecules.

Karl Folkers, executive director of fundamental research of Merck and Company, is to receive the 54th annual Perkin Medal, which is given in recognition of outstanding achievement in chemistry. The medalist is elected by a jury of award representing the American Section of the Society of Chemical Industry, the American Chemical Society, the American Institute of Chemical Engineers, and the American Section of the Société de Chimie Industrielle. Folkers will be honored at the annual Perkin Medal dinner of the Society of Chemical Industry, to be held on 5 February at the Waldorf-Astoria Hotel, New York.

Erratum: In the article by R. W. Hendler, "Self-absorption correction for carbon-14 [*Science* **130**, 772 (25 Sept. 1959)], the last term, a, in the fourth equation of the group in column 3, page 776, should have been the left-hand member of the fifth equation. The last three equations in the group should thus have read

$$0.32 = \frac{R}{I_\infty} m \left(\frac{10^{-am}}{1-10^{-am}} \right)$$

$$= 0.068m \left(\frac{10^{-am}}{1-10^{-am}} \right)$$

$$a = \log \left(\frac{m+4.7}{4.7} \right) \Big/ m$$

In addition, the units of specificity shown in the legends of Figs. 2 and 3 (page 774) should have been counts, rather than centimeters, per minute per milligram. In Table 1 (page 775), the seventh and ninth entries in column 1 should have been 2.47 and 120.0, mg/cm², respectively, not 24.7 and 74.

Book Reviews

A History of Western Morals. Crane Brinton. Harcourt, Brace, New York, 1959. x + 502 pp. $7.50.

It is always a pleasure to see a thoroughbred professional at work. Whatever may be wrong or weak in what he does—for a professional remains mortal and fallible, despite what laity and profession may at times believe — he knows what he is about and does not fumble. Professional training may reduce a man's stature, repress and dwarf his genius, so that he is less able to formulate startling truths, but one is at least sure that his errors and bathos will be of the accepted kind, which merges conveniently with truth and in its way supports truth until the time when the convention changes.

Crane Brinton's bold attempt to write in one volume the history of western morals shows him off as a magnificent professional. He moves with ease among the books, ideas, and persons that encumber three thousand years of western history, and puts each in its place sooner or later, with just the nod or pat that his ambitious scheme required. An epithet here, a comparison there, a footnote directing to an opinion or a study, a quotation from a text or one about a thinker or a thought—all these props of confidence or aids to verisimilitude are carried forward in the stream of the author's narrative without seeming to slow it up or alter its substance.

It is of necessity a peculiar narrative, since the subject is one that lies mainly outside public events. Ideas, conceivably, can be treated like events; they have a genesis and lead to consequences. But how can one impart a like sense of movement to the description of human traits which manifest themselves as habits—sometimes trivial—and which are diffused among the multitudes rather than concentrated in striking exemplars? The morals of the Dark Ages, the morals of the Renaissance—what can these phrases mean, once we have excluded moral *theories* and those moral acts that are conspicuous because uncommon?

Brinton has answered these awkward questions as the antimetaphysician is said to have shown the possibility of motion by moving. Brinton describes and discusses what he calls "conduct," from ancient Egypt to yesterday, by the simple expedient of having something to say about the apparent assumptions, the wills and acts, the social arrangements, and the ethical judgments of the peoples and periods recognized in political history.

When I say that he gives movement to these rapid and varied *aperçus* by presenting them as his impressions and his conclusions, I do not mean to suggest that he is egotistical or capricious. Rather, I mean that he adopts the simplest and best pedagogical device, which is to speak in the first person as one who has read and thought, rather than as an oracle or teletype machine. Indeed, Brinton's book is a gigantic lecture, in which "I" recurs naturally and effectively as the associative principle amid the discontinuous facts, intuitions, and conjectures. At times, the lecturing technique is carried to the point of self-consciousness, as when a footnote withdraws a qualifier in the text or throws doubt on a conclusion just stated: Brinton is thinking before his class, and warning them of his biases or improvisations.

In keeping with this stance, the diction of the book is colloquial. The French word *vulgarisation* properly describes the work, in that the term implies a desire to interest and instruct any reader of good will, often by conciliating his prejudices and ignorances as a first step to refining his views. The language of this rapprochement is therefore that of conversation, but since the chief modern prejudice takes the form of suspecting what is high, good, or great, the tone of the *vulgarisateur* is depreciatory. And so we find it in Brinton. Just as he self-consciously debunks himself in certain footnotes, so with a word he demolishes pretensions even before they are made. It is part reassurance, part entertainment. Thus, apropos of Homeric Greek life, we are given an enlivening aside: "There are the individual crotchety interpretations. Samuel Butler, the Victorian rebel against a Victorian father, wrote a book to prove the *Odyssey* was written by a woman." When one knows that Butler judged his weak and stupid mother as severely as he judged his stubborn and selfish father, one can see that the remark about Butler's interpretation of the *Odyssey* is irrelevant; and a first-hand knowledge of Butler's painstaking scholarly argument shows that whatever it may be called, crotchety is inadequate. Still, at that point in Brinton's narrative, some "relief" was needed—and supplied.

Without suggesting that these repeated intrusions of the modern, the ironic, the derisive are flaws to be removed, one may properly ask whether the work as a whole justifies its title and if so, whether it is a contribution to or a mere reexposition of the subject.

Perhaps the subject is an impossible one to treat. The needed materials are lacking, and a consistent handling of those available is very difficult. I, for one, start persuaded of this difficulty and near impossibility, and Brinton's book, I think, confirms the view. Whereas up to the end of the Middle Ages, Brinton deals in broad strokes with conduct and its premises in codes and religions, thereafter he sinks deeper and deeper into the magma we now call Culture. It is then ideas and philosophies that chiefly occupy him—Darwin, Weber, and Toynbee—rather than the behavior of groups and representative men.

It is only fair to add that at intervals throughout the book one encounters sections upon the sexual morality of the period. But as the author is the first to say, a true account of morals in this limited sense is hard to come by. And he is aware that the rules governing the appetites form but a small part of the domain of conduct. If literature, despite its preoccupation, gives us but an imperfect view of the relations of the sexes, we can hardly hope to find in either our ordinary or professional reading the evidence we seek about political, social, financial, intellectual, and spiritual morality. Or I should

rather say: no one has yet begun to reread the sources with these subjects in mind. Letters, diaries, state papers, business records must be consulted anew before we can say that we know or that we cannot know how people generally behaved in these matters at any time or place.

Meanwhile, Brinton's book will have to serve as a general introduction to the terrain and its pitfalls. The author's colleagues will point out some errors of fact (for example, Shaw's ascribing the poverty of the poor to a deficiency of the Life Force), some neglect of special studies (for example, Percy Scholes on the Puritans and Music), and some lapses of judgment (for example, the supposition that Matthew Arnold wrote "in those rosy Victorian times"). But accepting the effort to write a history of morals in the same spirit of courageous modesty as the author's, professional and lay readers alike must recognize in Brinton's book the first outlines of a great subject. If Lecky's similar work covering a relatively short span gave historians some notion of what could be done, Brinton's gives, by its oversights as well as its merits, an equally good notion of what ought to be done.

JACQUES BARZUN
Columbia University,
New York, New York

American Universities and Federal Research. Charles V. Kidd. Harvard University Press, Cambridge, Mass., 1959. xii + 272 pp. $6.

The expansion of federal support for scientific research is inevitable. The reason is that the traditional functions of government — maintaining order, providing for national defense, and promoting general welfare — can no longer be carried out without a vast understructure of scientific knowledge. The federal government undertakes to secure a large part of the scientific knowledge it needs by contracting with the colleges and universities of the country to carry out research projects. This book addresses itself to the central problems created by these contractual relationships—problems of reconciling the federal government's need for scientific knowledge with the traditional nature and activities of higher education.

These contract relations have been sources of anxieties both to government agencies and to universities, and a number of inquiries and reports have addressed themselves to the subject. It is no disparagement of the previous studies to say that this book, itself profiting from its predecessors, supersedes them and will become a starting point for all future discussions of the subject. Kidd writes with the authority he has gained not only from his associations and contacts with such government agencies as the National Institutes of Health, the National Science Foundation, and the Department of Agriculture, but from extensive contact with universities and from travel and observation abroad. In addition to this basic equipment of confident knowledge, the author brings to the discussion a refreshing degree of courage and candor, infusing with stimulating opinion and observation the statistics which are so often the lifeless material of such studies.

It would be difficult to improve on the author's statement of the central problems created by federal support of research in the universities. Such support, he believes, has "set in motion irreversible forces that are affecting the nature of universities, altering their capacity to teach, changing their financial status, modifying the character of parts of the federal administrative structure, establishing new political relations, and changing the way research itself is organized." No one would deny that these are formidable consequences, and that the author is justified in saying "the wisdom with which these forces are guided and controlled by the universities and by the federal government will have a major influence not only on the capacity of the nation to defend itself, but on the economic growth of the nation and the preservation of the essential values that underly our society."

To the exploration of this thesis Kidd brings logical analysis and organization, as well as a vast amount of pertinent information. Here are some of the questions he undertakes to answer: What research does the federal government want done? What funds does it have to support such research, and how and by what agencies are these funds distributed? What conditions are imposed upon universities which seek or accept grants, and are these conditions compatible with proper university functions? What is the effect on universities of their growing dependence upon federal research support as reflected in their teaching, their independent research, and their self-direction? How does the flow of federal funds into universities affect university finances generally? What is the effect of federal research contracts on university organization and operation? What are the consequences of federal support for graduate students, and how does such support affect the supply of future scholars? How does the favoring of science affect other sections of the curriculum? How, above all, is the relationship affecting the freedom of the universities?

Everyone in government or in the universities who is concerned about such matters can only be grateful to Kidd for the factual data, the considered opinions, and the actual experiences which have been assembled to answer not only these broad questions but dozens of others more specific. The university administrator who has been worried about the effect on teaching of the emphasis on research, the distortion of faculty salaries, and growing overhead costs will find his problem clearly stated here, as well as some worthwhile observations for his comfort or guidance.

An outstanding feature of the author's treatment is the concern he shows for the basic values of our society, democracy, equality of opportunity, and particularly intellectual freedom, as these values may be affected by the changing relations between the federal government and the universities. Kidd regards freedom as the one characteristic which makes universities different from all other research organizations. Policies, either from within or without, which have the effect of restricting freedom can only be suspect. Indeed, one gets the impression that Kidd is a little more concerned about the freedom of the universities than he is about whether the federal government secures the fruits of scientific research—a conclusion which, if correct, can only be entertained when the needs of government are not overwhelmingly urgent. Fortunately, says Kidd, the policies governing the administration of federal research programs are no great threat to the freedom of the universities. These policies, however, as Paul E. Klopsteg says in this book's excellent foreword,

will require the most earnest attention if we are to increase our national competence in science and technology while keeping the universities intellectually vigorous and administratively independent.

HAROLD W. STOKE

Queens College,
New York, New York

Sea Shells of Tropical West America. Marine mollusks from Lower California to Colombia. A. Myra Keen. Stanford University Press, Stanford, Calif., 1958. x + 624 pp. Illus. $12.50.

Myra Keen's book truly fills a long-felt need, for prior to its appearance there was no adequate handbook dealing with the mollusks of the area it covers.

Like R. Tucker Abbott's *American Sea Shells*, with which it will inevitably be compared and to which it serves as a companion volume as far as the west coast of tropical North America is concerned, this volume necessarily deals with only the commoner and larger mollusks of the littoral region and the shallow waters. About 1650 species are briefly described, and of these, approximately 1500 are illustrated. Most of the figures are in black-and-white, but 11 species are superbly depicted in color. It is a pity that better use was not made of these fine color plates through portrayal of more than one species on a plate. However, the author is to be commended on the arrangement of the volume; the illustrations are grouped together as text figures so that, in almost all cases, the descriptions and illustration of a species fall on the same page or on opposite pages. Another valuable feature of this volume is the frequent use of keys to the genera of the larger families and, occasionally, to the subgenera and even to species within a genus.

The smaller species are only cursorily mentioned, since, to have included all of the many species that have been described in some of these groups would have considerably increased the volume of the book. In such groups as the Eulimidae, the Rissoacea, the Vitrinellidae, the Caecidae, the small Cerithiidae, and most of the Pyramidellidae, only representatives of the genera are illustrated; in most cases the illustrations are accompanied by keys. For the Epitoniidae there is a key to the genera and subgenera, and all known species are listed (though not described), but only 58 percent of them are illustrated; this is somewhat unfortunate, since species of this family are frequently found in collections because of their rather striking appearance.

A number of valuable appendices follow the main body of the text; these include a short two-page glossary of terms, a series of useful keys to the superfamilies of pelecypods and to superfamilies and families of gastropods, and a valuable list of sources for the figures used. I might mention here that about 70 type specimens are illustrated in this book for the first time. The valuable 30-page bibliography and the index are followed by four pages of addenda that give some final changes and corrections made by Keen while the book was in page proof; most of the changes and corrections are the result of Keen's examination of types in the British Museum.

Both professional malacologists and marine biologists, as well as amateur collectors who gather shells on the sandy beaches and rocky shores of the west coasts of Mexico and Central America, owe a debt of gratitude to Myra Keen for this extremely useful and authoritative reference book. I hope that someone equally gifted will be induced to write a similar volume on the Caribbean molluscan fauna.

HARALD A. REHDER

U.S. National Museum,
Smithsonian Institution

Larousse Encyclopedia of Astronomy. Lucien Rudaux and G. de Vaucouleurs. Revised by Z. Kopal. Prometheus Press, New York, 1959 (order from Putnam's, New York). 506 pp. Illus. Until 1 Jan., $12.50; after 1 Jan., $15.

This beautifully produced volume is a pleasure both to read and to behold. It is, as the name states, an encyclopedia—a 500-page quarto volume—and its double columns are very liberally interspersed with 806 excellent photographs and drawings, as well as 12 beautiful color plates.

Instead of containing an alphabetically arranged collection of short articles, the text is arranged by chapters in much the same manner as has become conventional for college textbooks—that is, an introduction followed by chapters that discuss the earth, the solar system, and so forth. This arrangement greatly enhances the readability, for once the reader has looked up a particular subject in the very adequate index, he will plunge into the text only to find, half an hour later, that he has long since covered the point in question and has read on for pages on allied subjects. While the authors have included practically no mathematics, they have not hesitated to provide word explanations or drawings of astronomical phenomena, and whatever can be made clear in this fashion is well taken care of. There is a profusion of numerical and tabular information—for example, a list of 184 lunar craters, 20 maria, and 13 mountain ranges, all identified on an accompanying plate.

All in all, this is an excellent reading and reference volume for interested high-school and beginning college students, for parents whose children ask embarrassing questions, and even for the professional astronomer who likes to have a handy elementary reference book at his elbow.

There is one shortcoming which must be mentioned, however. Aside from certain rather limited revisions made recently by Kopal, the text was apparently written about 1946. It is disappointing to find that no photographs taken with the 200-inch telescope are reproduced, that only two or three pages are devoted to radio astronomy, and that very little of the results of rocket, satellite, or balloon astronomy are covered. The inclusion of Russell's table of 1942 showing the evolution of the sun from spectral type dK8 through dG2 to type B9 seems a little quaint.

GEOFFREY KELLER

Astronomy Program,
National Science Foundation

A Reader's Guide to the Social Sciences. Bert F. Hoselitz, Ed. Free Press, Glencoe, Ill., 1959. 256 pp. $2.95.

Well over 100 years ago Auguste Comte dreamed of a synthesis of social science. Peter Odegard has stated that the mood of the postwar generation is one of specialization and integration among the major disciplines. Hoselitz and his colleagues have performed a service by implementing, in part, Comte's concept and Odegard's observation with a book that provides something more than a thumbnail review of the development of the literature of social science. The book represents a point of departure for further, more

substantive treatises in this direction.

The volume is useful to the specialist, who will gain from an overview of the literature of allied disciplines. Similarily, it is of value to the general reader and the librarian interested in works on social science. The natural scientist will be delighted to find that it is not merely a curious bibliography but, to a considerable extent, an introductory text in a very vital area that is of increasing interest to natural scientists. The contributors not only discuss the important personalities and the historically important writings but also indicate the present state of each field and mention many of the contemporary scholars who are doing significant work in these fields.

The shortcomings of the book are few. The editor was generous and included anthropology, geography, history, and psychology with the pure social sciences—economics, political science, and sociology. In my opinion, the volume would have been strengthened by the inclusion of a separate section on statistics, which emphasized applications to empirical analysis—so important to the current position of the science of society. The empirical function, however, is treated summarily within the various sections of the book.

This unique work deserves to be very widely read, both at home and abroad, by all intellectuals and by scientific technicians. And I am not being facetious in the least in stating, especially in view of Chairman Khrushchev's recent travels, that the volume should be required reading, preferably in translation, within Kremlin walls.

DONALD P. RAY
National Institute of Social and Behavioral Science,
George Washington University

Features and Formation of the Great Kawir and Masileh. Hans Bobek. Arid Zone Research Centre, University of Teheran, Teheran, Iran, 1959. 63 pp. Illus. 1 map.

This detailed description of a complex of desert basins southeast of Teheran on the Iranian plateau is based on a study of air photographs, supplemented by ground reconnaissance in parts of the area. The monograph includes some excellent reproductions of vertical photographs showing huge alluvial fans, salt basins, partly buried folds, and sand-dune complexes.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Algae in Water Supplies. An illustrated manual on the identification, significance, and control of algae in water supplies. C. Mervin Palmer. U.S. Public Health Service, Washington, D.C., 1959 (order from Supt. of Documents, GPO, Washington 25). 88 pp. $1.

Archeological Excavations at Jamestown. Colonial national historical park and Jamestown national historic site, Virginia. John L. Cotter. U.S. Department of Interior, Washington 25 (order from Supt. of Documents, GPO, Washington 25). 289 pp. $2.75.

Biological Series, Michigan State Univ. vol. 1, No. 5, *The Bog Lemming* Synaptomys cooperi *in Southern New Jersey*, Paul F. Connor, 10 pp. vol. 1, No. 6, *Notes on Reptiles from the Mexican State of Durango*, Robert G. Webb and Max Hensley. vol. 1, No. 7, *New Vertebrate Fossil Localities in the Vale Formation (Lower Permian) of North-Central Texas*, Richard J. Seltin, 10 pp. Michigan State Univ., East Lansing, 1959.

Chimie et Radioactivité Atmosphériques. J. Grandjean. 24 pp. *Nouvelles de l'Espace.* M. Nicolet. 19 pp. Institut Royal Météorologique de Belgique, Brussels, 1959.

Cold Acclimatization in the Golden Hamster. vol. 20, No. 3. Richard L. Farrand, State Univ. of Iowa, Iowa City, 1959. 29 pp. $0.50.

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The General-Field Law and the Structural Nature of Matter. Based on the mechanics of vector dynamics. A. D. Sarantites. Plastonics Corp., Moorestown, N.J., 1959, 131 pp.

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How to Identify and Name Soils. Use of scorecard for identifying and naming soils. R. Earl Storie. Univ. of California, Berkeley, 1959. 55 pp. $1.

Instrumentation for Geophysics and Astrophysics, No. 12, AFCRC-TR-59-244: *Theoretical Analysis of the Par-Scope: and Oscilloscope Display for Weather Radars*, Edwin Kessler, III, 36 pp. Geophysical Research Papers, No. 59, AFCRC-TR-58-235(3), vol. 3: *Project Prairie Grass, a Field Program in Diffusion*, Duane A. Haugen, Ed. 673 pp. Geophysics Research Directorate, Bedford, Mass., 1959 (order from U.S. Dept. of Commerce, Office of Technical Services, Washington 25).

Introduction to Mathematical Psychology. 32 pp. *Studies in Indian Psychology.* 54 pp. S. K. Ramachandra Rao. All-India Inst. of Mental Health, Bangalore, 1959.

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Reports

Masculinity and Smoking

Abstract. Study of the relative strength of the masculine component in a series of males reveals a significant association with their differential smoking habits. Weakness of the masculine component is significantly more frequent in smokers than in nonsmokers and most frequent in the heavier smokers.

In order to obtain a fuller understanding of the apparent relationship of heavy smoking to lung cancer and coronary disease, it is pertinent to inquire into the nature of the individuals who practice the smoking habit—their personality, physiology, and biogenetic characteristics. The basic data of the Study of Adult Development (Grant study) of the Harvard University Health Service affords an unusual opportunity for the exploration of some of these factors, in so far as they provide longitudinal smoking information on a group of Harvard alumni over a period of more than 15 years. Portions of this material have already been reported in connection with the psychology of smoking (*1*) and with a variety of personality, physiological, medical, and social data (*2*). This report deals with one aspect of the somatic biogenetic material—namely, the masculine component of these men as related to their smoking habits.

The basic data on which this analysis is based are derived from a longitudinal study of 252 Harvard College sophomores first seen between 1938 and 1942, who were selected for their lack of visible abnormality. The details of the project, including the methods, the procedures, and the nature of the material collected, have been described elsewhere (*3*). When first seen the subjects were examined for an extensive range of medical, physiological, anthropological, and sociological information. Since then these men have been followed through annual questionnaires, retesting, and visits in order to obtain a variety of factual material, including data on their smoking habits.

A complete description of the collection of the data on smoking has already been presented by Heath (*2*). The smoking habits of the subjects were recorded during the initial medical examinations made between 1938 and 1942, and the number of cigarettes, pipes, and cigars smoked per day was specified. Subsequently, similar information was obtained from the participants through the medium of annual questionnaires over a period of more than 15 years. From these data it has been possible to construct a threefold classification of nonsmokers (24.3 percent), moderate smokers (38.0 percent), and heavier smokers (37.7 per cent), based on the long-term observation of the smoking habits of the subjects.

In the course of the physical anthropological examination of the subjects when they were still college sophomores, between 1938 and 1942, each individual was rated with respect to a body-build complex known as the masculine component (*4*). The term *masuline component* refers to the element of masculinity in the individual as indicated by his external morphological features. The more the pattern of anatomical traits tends toward the extreme masculine form, the stronger is the masculine component; the greater the departure from the extreme masculine type towards the more feminine build, the weaker is the masculine component in the individual. The gradations from the strong masculine component to the very weak masculine component form a continuum. Nevertheless, with the aid of a standardized chart, individuals may be readily characterized as having a strong, moderate, weak, or very weak masculine component. A description of the morphological traits indicative of the weakness of the masculine component and illustrations of the various categories have been published elsewhere (*4, 5*). In practice, the rating of men for strength of the masculine component is relatively simple, and the degree of reliability of the ratings is very high. This is the same element in the morphology of the individual which Sheldon has referred to as gynandromorphy (*6*).

Table 1 presents the distribution of the individuals in our series according to strength of the masculine component and smoking habits. The data show that there is a significant association between the strength of the masculine component and the smoking habits of the subjects (P is less than .05) (*7*). More specifically, weakness of the masculine component is significantly more frequent in smokers than in nonsmokers, and significantly more frequent in heavier smokers than in nonsmokers and moderate smokers combined (P is less than .05). It is interesting to note that the increased frequency of the degree of weakness of the masculine component from the nonsmokers to the heavier smokers is consistent and progressive. Thus, while only 3.3 percent of the nonsmokers have some degree of weakness of the masculine component, the percentage rises to 9.6 in the moderate smokers and 17.2 in the heavier smokers. At the same time, the heavier smokers show the greatest proportion of individuals with weak or very weak masculine components.

Although these findings are highly interesting and most suggestive, it must be clearly recognized that they should be considered as preliminary and tentative in nature, pending confirmation from future studies designed to illuminate this area of concern.

But the data as they stand lend evidence to the nature of the biogenetic characteristics involved in human behavior, and to the role of the physical constitution in the total personality of the individual. The body-build complex, the masculine component, must be rec-

Table 1. Data showing the relationship between the masculine component and smoking habits ($N = 247$).

Non-smokers		Moderate smokers		Heavier smokers	
No.	%	No.	%	No.	%
Strong masculine component					
58	96.7	85	90.4	77	82.8
Moderate masculine component					
2	3.3	7	7.5	8	8.6
Weak masculine component					
		2	2.1	7	7.5
Very weak masculine component					
				1	1.1
Totals					
60	100.0	94	100.0	93	100.0

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

ognized as a feature of the genotype and as being ostensibly unaffected by environmental considerations. The fact that we find individuals with weakness of the masculine component most heavily represented in the smoking group, and especially in the heavier smoking category, suggests that for a specified type of individual smoking may be a reflection of certain personality and behavioral traits which are characteristic of his biological make-up.

In this connection, it is to be noted that in a previous study the individuals with weakness of the masculine component "exhibit a characteristic pattern of traits which form a consistent and harmonious picture" (*4*). These less masculine persons tend to have an aversion for strenuous exercise and sports, are apt to be low in physical fitness for hard muscular work, and are often poor in muscular coordination. In the sphere of personality structure, they appear to be more sensitive in affect and manifest a greater degree of instability of the autonomic nervous functions. They are apt to be less well integrated and more ideational, creative, and intuitive. They are more frequently shy and asocial and more frequently have traits of self-consciousness and inhibition. In the formal intellectual functions they tend to rank higher in the verbal functions and possibly lower in the mathematical or number functions. Academically, they most often select the area of arts, letters, and philosophy as a college major, and their choice of career tends to follow these same lines of interest. What is significant here is the fact that this constellation of personality and behavioral traits for the individuals with weakness of the masculine component is for the most part not inconsistent with the findings of Heath (*2*) in his study of the differences between smokers and nonsmokers.

If further studies confirm the findings of this report, an important line of investigation should be explored which may bear on the question of the association of smoking with lung cancer and coronary heart disease. In view of the fact that smoking is found here to be significantly more frequent in individuals with weakness of the masculine component, then it would be pertinent to determine the differential frequency of lung cancer and coronary disease in males according to the strength of the masculine component in both smokers and nonsmokers. Such data would help establish whether differences exist in disease incidence between the classes of individuals within this genotypical body-build complex, and whether the element of smoking materially changes this incidence. Thus, it may be possible to secure evidence on the extent to which smokers and nonsmokers differ in their susceptibility to disease because of their biological nature, apart from the element of smoking itself (*8*).

CARL C. SELTZER
Peabody Museum, Harvard University, Cambridge, Massachusetts

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7. The statistical significance from which P values given in this report are derived is based on the chi-square method of computation.
8. This study was supported by the Tobacco Industry Research Committee and based on data of the Study of Adult Development of the Harvard University Health Service.

13 August 1959

Method for the Study of Antigenicity of Homologous Whole Spleen Cells in Mice

Abstract. A method for the quantitative assay of the antigenicity of homologous mouse whole spleen cells in the system of A/Heston (donor) to C57BL/6 (recipient) is described. The assay is based upon the graded response of skin homografts to the numbers of donor cells injected intraperitoneally into the recipient prior to the skin graft. The response is linear with respect to the logarithm (base 10) of the number of cells injected.

Billingham and Medawar and their coworkers (*1*, *2*) have studied the sequence of changes in the skin graft implanted upon a homologous host. After an initial period of acceptance, there is a gradual rejection of the graft. If a second graft from the same donor, or from a donor of the same inbred strain, is implanted on the recipient, there is an accelerated rejection of the homograft. This phenomenon, as it has been defined in the experimental animal, is considered to have an immunologic basis. Accelerated rejection of a skin graft also occurs if a parenteral injection of whole splenic cells from the donor or donor strain is substituted for the initial skin graft (*2*). Billingham, Brent, and Mitchison (*3*) noted that, as the number of injected whole splenic cells from the donor strain of inbred mice was decreased (a decrease which represented a decrease in antigenic stimulus), then there was amelioration of accelerated rejection.

This observation suggested to us that there might be a dose-response relationship which could be defined by quantitative studies. We have found a direct correlation between changes in skin homografts and the number of splenic cells administered intraperitoneally before the application of the skin graft. The correlation has a sufficiently high degree of statistical significance to make the procedure described below of use in determining the antigenic potency of whole cells and cellular fractions.

1. *Experimental animals.* Pure-strain adult A/Heston (A/He) male mice (donors) and adult C57BL/6 male mice (recipients) obtained from the Roscoe B. Jackson Laboratories, Bar Harbor, Me., were used in these experiments.

2. *Preparation of cells.* Whole spleens (of A/He mice), freed from fat, were cut longitudinally, and the contents were gently pressed and washed with Ringer-Locke solution through a stainless-steel screen (40 to 60 mesh). Cell clumps were very gently dispersed into a uniform suspension by allowing the loose plunger of an all-glass homogenizer [described by Dounce (*4*)] to fall under its own weight with restraint. Cell counts were made in a hemocytometer, 3-percent acetic acid being used as the diluent. The first suspension was subdiluted (with Ringer-Locke solution) to the desired concentrations, and each of these was counted.

3. *Injection schedule.* Six groups of six mice each were injected intraperitoneally with whole homologous spleen cells as described above; a seventh, uninjected, group served as a negative control. The six doses were 0.05, 0.1, 0.2, 0.5, 1.0, and 2.0×10^6 cells, respectively. The cell suspensions were so diluted that all injected volumes were 1.0 ml.

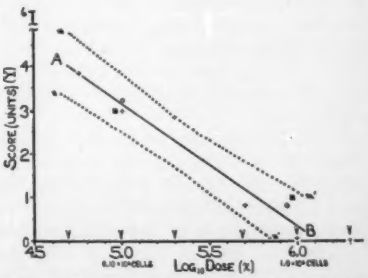

Fig. 1. Dose-response regression of skin homografts to prior antigenic stimuli (intraperitoneally-injected homologous spleen cells, isologous with graft). Experimental points for the regression line, + (in two subsequent experiments, ■ and ○); calculated regression line, AB; confidence limits at $P = 0.05$ for AB, mm', and nn'. The equation for the regression is $Y = 17.18 - 2.81x$.

4. *Grafting.* Four days after injection, skin homografts (A/He), 1 cm square and of full thickness, were placed on the panniculus carnosus of each recipient and control, according to a modification of the technique devised by Billingham and Medawar (*5*).

5. *Histologic evaluation and scoring.* The method of scoring depends upon the observation that an initial skin homograft on a mouse is largely viable on the 6th day after grafting, while, in contrast, a homograft on a mouse which has received a prior antigenic stimulus in the form of either a skin homograft or of whole homologous cells introduced intraperitoneally is partially or totally necrotic by the 6th day (*6*).

Each homograft with its bed was therefore excised on the 6th day and fixed in neutral, buffered Formalin. Grafts were cut transversely into thirds, embedded in paraffin, and stained with hematoxylin and eosin. Sections were then examined microscopically. The percentage of necrotic epithelial cells of the surface and of the hair follicles of each homograft was estimated from the appearance of all three graft sections, and the results were scored with the following values: 0, 10, 25, 50, 75, 90, and 100 percent of surviving epithelial cells. For convenience in statistical analysis, these values were transformed to integers 0 through 6, respectively.

We have found that the scores of control skin homografts (first set) were statistically indistinguishable on the 5th and 6th days. The scores for homografts placed after a single maximal antigenic stimulus (20×10^6 homologous whole spleen cells, injected intraperitoneally) and excised on the 6th day were significantly smaller than the scores for those excised on the 5th day ($0.005 < P < 0.01$).

6. *Control values.* The mean score for control homografts on the 6th day for seven different experiments was 4.75 units (standard error, $\pm$ 0.174, $N = 55$). (This is equivalent to between 75- and 90-percent survival of epithelial cells.)

7. *Reproducibility of scoring method.* Seventy-five slides, chosen at random, were reexamined, and scores of the first and second readings were compared. A statistical analysis of the differences in paired data showed that there were no significant differences between the original and the repeat readings.

In Fig. 1, the injected doses are indicated by arrowheads above the abscissa; the units of the abscissa are the logarithms (base 10) of the number of injected cells. The mean scores for the individual test groups are shown by the crosses. The dose-response, represented by the solid line *AB*, was obtained by the method of least squares from the observed points (crosses); all but the highest dose ($6.3 = \log_{10} 2 \times 10^6$ cells), of which the mean score and variance were zero, were used. The dotted lines *mm'* and *nn'* are the confidence limits at $P = 0.05$ for the regression line (*not* for data for the individual groups). The other symbols (squares and circles) indicate the observed dose-response in two subsequent experiments. By means of statistical analysis, the regression is found to have a very high order of probability ($P < 0.001$) (*7*).

It is evident that a significant response can be measured over a 20-fold range in dose, linear with the logarithm of the dose in the range of 50,000 to 1 million cells (*8*).

LEWIS T. MANN, JR.
JOSEPH M. CORSON
GUSTAVE J. DAMMIN
Departments of Pathology, Harvard Medical School and *Peter Bent Brigham Hospital, Boston, Massachusetts*

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8. We wish to thank Mindel C. Sheps of the department of preventive medicine, Harvard Medical School, for her assistance and advice in the statistical analyses and also to acknowledge gratefully the technical assistance of Gertrude Lustig and Gayle A. Schaeff. This work was supported by a grant from the U.S. Public Health Service (H-1771) and a contract with the U.S. Army Medical Research and Development Command.

14 July 1959

Cytopathic Effect of Canine Distemper Virus in Tissue Culture

Abstract. A characteristic cytopathic effect was obtained with canine distemper virus (Onderstepoort strain) propagated in chick embryo fibroblast monolayer tissue culture. In limiting dilutions the lesions were focal. The titer at the 20th tissue culture passage was approximately 10^5 TCD_{50}/ml. Cytopathogenicity was specifically inhibited by distemper immune serum. Minute plaques were produced under agar overlay.

Studies of canine distemper virus (CDV) have been handicapped by the lack of a tissue culture system in which the virus produces visible lesions. In addition to the veterinary importance of distemper virus, interest has been stimulated by the recently observed serologic relationship between CDV and measles virus (*1*).

Table 1. Titration of tissue-culture-adapted CDV in the chick embryo and in chick fibroblast tissue culture.

Chick embryo CAM* (ID_{50})	Tissue culture fluid medium (focal lesions)	Tissue culture agar overlay (pfu)†
Tissue culture passage level: 10		
2.1×10^4‡	2×10^5	4.2×10^5
Tissue culture passage level: 20		
2.9×10^4	1×10^5	6.2×10^5

* CAM, chorioallantoic membrane. † pfu, plaque-forming units. ‡ Titer/1.0 ml.

Tissue cultures were prepared by trypsinization of 11-day-old chick embryos (*2*). The cells were suspended in Earle's saline containing 75 mg of $NaHCO_3$ per 100 ml, 0.25 percent lactalbumin hydrolyzate, and 4 percent calf serum. Ten milliliters of the cell suspension (900,000 cells/ml) were added to 4-oz prescription bottles, and confluent monolayers were obtained within 24 hours. The virus employed was the egg-adapted Onderstepoort strain (*3*) of CDV (208th embryo passage) (*4*). Tissue culture passage was initiated by inoculation of 1.5 ml of a stock CDV chorioallantoic membrane suspension (20 percent) which had been stored at −70°C. A control series of tissue cultures was initiated with an inoculum of uninfected chorioallantoic membrane. The cultures were inoculated at 24 hours and maintained in a medium consisting of 50 percent bovine amniotic fluid, 2 percent calf serum, and 48 percent Earle's saline, containing 75 mg of $NaCHO_3$ per 100 ml. This medium maintained cells in good condition for 3 weeks without further exchange. The early passages were harvested between the fifth and ninth days, and beginning with the 14th passage, on the third or fourth day. The cultures were harvested by scraping. The cells plus supernatant fluid were passaged without storage or freezing. Beginning with the 15th passage, the cytopathic effect was sufficiently rapid that the fibroblast monolayer could be maintained adequately in the original growth medium and therefore no exchange with maintenance medium was necessary. The present passage method (32nd passage) consists of the inoculation of 0.1 ml of undiluted supernatant plus cells simultaneously with the plating of the trypsinized chick cell suspension in the growth medium. The fibroblast monolayer forms within 24 hours and cytopathic effect appears in the formed sheet at 48 to 72 hours. Two of three other attempts to establish the Onderstepoort strain of CDV in this system were successful.

The characteristic cytopathic effect first appeared in the 2nd passage and became more rapid and destructive with increasing passage. With undiluted inoculum of adapted virus, the lesions were widespread by the third day and consisted of granular rounding up and fragmentation of the cells (Fig. 1). The cells remained adherent to the glass, but eventually many were shed into the supernatant fluid. There was no evidence of formation of giant cells or syncytia. With smaller virus inocula, the lesions appeared later, were focal, and remained localized for as long as 2 weeks after initial appearance. These focal lesions could be counted with the unaided eye and the number was proportionate to the virus input. Under agar overlay, minute plaques, 0.5 to 1.0 mm in diameter, were present, which were best counted under oblique light, where they appeared as gray-blue opalescent centers.

The titer at the 10th and 20th passages was determined by the appearance of lesions on the chorioallantoic membrane of the chick embryo and also by focal lesion count in the fibroblast monolayer under fluid medium and by use of the agar overlay technique (Table 1). The three methods showed essentially similar titers.

The identity of the agent responsible for the cytopathic effect was determined after 10 and 20 passages in tissue culture. When the tissue culture virus was back passaged on the chorioallantoic membrane, typical punctate and linear lesions were observed as described previously for the Onderstepoort strain (*5*). The chorioallantoic membrane and tissue culture lesions were inhibited by antiserum obtained from a dog following experimental infection with the virulent Snyder Hill strain of CDV, and were not inhibited by the preinfection serum (*4*). Neutralization of chorioallantoic membrane and tissue culture lesions was also demonstrated by using chicken hyperimmune serum that had been prepared from the original parent chick-embryo-adapted Onderstepoort strain.

Rockborn (*6*) reported the growth of a virulent "street" strain of CDV in dog kidney tissue culture with production of multinucleated giant cells, similar to that seen with measles virus. The difference in cytopathology of CDV in dog kidney and chick embryo as described above is notable.

An egg-adapted CDV strain (Lederle) has recently been reported to multiply without cytopathic effect in chick embryo tissue culture (7). The tissue-culture-adapted Lederle strain (35th passage) (*4*) readily produced typical cytopathic effect in chick tissue culture prepared as described above, but failed to cause cytopathic effect in cultures grown in Eagle's solution containing 10 percent horse serum and maintained in mixture 199, as described by Cabasso (*7*). Tissue-culture-adapted Onderstepoort strain, however, was rapidly cytopathic in cells handled with either technique. The above results indicate that differences in both virus strain and cultural conditions may be important in the manifestation of tissue culture cytopathology by CDV.

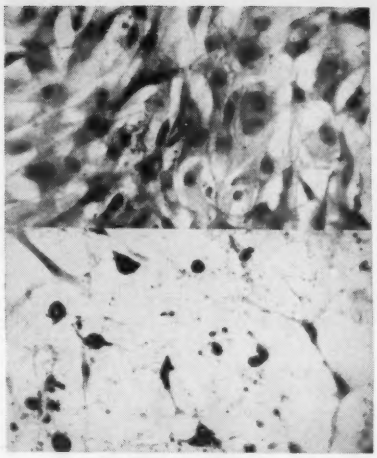

Fig. 1. (Top) Normal chick fibroblast monolayer tissue culture, day 5, hematoxylin and eosin stain; (bottom) same, infected on day 0 with canine distemper virus (× 285).

The adaptation of CDV to chick fibroblast culture with the rapid formation of specific lesions provides a tool for the further development of quantitative methods of virus titration and serologic study (*8*).

DAVID T. KARZON*
ROBERT H. BUSSELL
Department of Pediatrics and
Department of Bacteriology and Immunology, University of Buffalo School of Medicine, Buffalo, New York

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4. CDV (Onderstepoort strain) and canine antiserum were kindly supplied by Dr. James H. Gillespie, Veterinary Virus Research Institute, New York State Veterinary College, Cornell University, Ithaca, N.Y. CDV (Lederle strain) was kindly supplied by Dr. Victor J. Cabasso, Lederle Laboratories, Pearl River, N.Y.
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8. This study was aided by a grant from the National Foundation.
* Markle scholar in medical science.
30 July 1959

Evidence That Cut Optic Nerve Fibers in a Frog Regenerate to Their Proper Places in the Tectum

Abstract. The frog's retina projects into the superficial neuropil of the opposite tectum in four functionally different layers of terminals. Each layer displays a continuous map of the retina in terms of its particular function. The four maps are in register. The fourth-dimensional order is reconstituted after section and regeneration of the optic fibers.

Sperry (*1*) pointed out that the results of his experiments on optic nerve regeneration in adult frogs were consistent with specific reconnection of the optic fibers. He proposed that each individual neuron grew back to its original terminus in the tectum, for the behavior after visual recovery was as if the nerve had not been cut. In addition to the behavioral evidence, he produced scotomata in predicted quadrants by fairly large tectal lesions in frogs that had regrown their optic connections. The implications of his proposal are so odd that, while his elegant experiments were accepted, the interpretation was much disputed. Furthermore, the experiments with tectal lesions cannot be considered conclusive, since, by destroying part of the tectum, the ability of the animal to respond is also impaired. The purpose of this communication is to give electrophysiological evidence in support of Sperry's hypothesis.

We have developed a technique for recording single fibers in the frog's optic nerve and single terminal bushes in the tectum (*2*). In this work we have found that normally the frog's tectum has the following organization. The fibers of each optic nerve cross completely in the optic chiasma and enter the opposite colliculus after dividing into two bundles. One is rostromedial; the other, caudolateral. They sweep over the surface and are distributed in several layers in the outer neuropil that forms the superficial half (250 μ) of the tectal cortex (Fig. 1). Most tectal cell bodies lie below this neuropil and send their main dendrites through it up to the pial surface. The axons of the majority of these cells form a narrow stratum that lies immediately above the compact layers of cell bodies. The optic fibers end in a systematic way both along the surface and in the depths of the superficial neuropil, mapping the retina in a pattern that is constant from animal to animal. There are four layers of these optic fiber terminals, which we have thus far identified only physiologically. Each displays a continuous map of the retina with respect to each of the four following operations on the image at the receptors. The four maps are in register with each other and

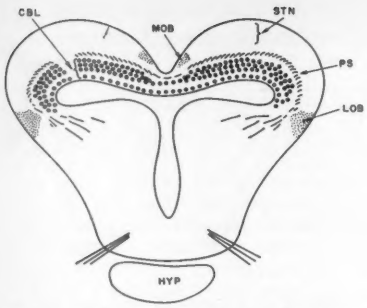

Fig. 1. Transverse section of the tectum of the frog at the level of the oculomotor nerves. CBL, cell-body layers; MOB, medial optic bundle; STN, superficial tectal neuropil; PS, palisade stratum; LOB, lateral optic bundle; HYP, hypophysis.

show position on the retina according to the cartography of Gaze (*3*).

The first layer of terminals is formed by those elements each of which is sensitive to moving or maintained contrast within its receptive field. The sharper the contrast, the better the response. These are equivalent to Hartline's (*4*) and Barlow's (*5*) "on" fibers. The second layer is made up of terminals of units each of which detects a moving or recently stopped boundary within its receptive field, provided there is a net positive curvature of the edge of the darker phase. Such a fiber will not respond, for example, to a straight-edge boundary moving across its receptive field or to a preestablished edge within that field. Both of these strata represent the endings of the unmyelinated fibers of the optic nerve.

The third layer is made up of terminal bushes from "on-off" fibers.

The fourth layer is composed of endings from "off" fibers.

The layers of endings are distinct in depth, and with the exception of the first and second layers they rarely merge at the transition zones. In this conspicuous order, both along the surface and in the depths, the area of the retina "seen" from any point in the superficial neuropil is, at most, 10° in radius. Most of the ganglion cells whose terminals appear at that point are crowded toward the middle of that area.

For the purpose of testing Sperry's hypothesis of the specific regrowth of the optic fibers after section of the optic nerve, we cut one optic nerve in several adult frogs (*Rana pipiens*), ensuring the complete separation of the two stumps. At the end of 2 months the first signs of visual recovery were apparent, but full use of the eye did not occur for another month. When the visual recovery seemed complete, we exposed the colliculi and tested the initially deafferented colliculus for mapping of the retina. We found that the map had been regenerated along the surface, although the ganglion cells from whose terminals we were recording at any point were now spread over an area about two times as large as normal. The separation of operations in depth was also restored, and there was no sign of confusion between the operational layers.

The specific regrowth of the terminals to their proper stations cannot be explained by saying that an initial orderly array of fibers in the optic nerve crudely orders the fibers again at the time of regeneration. The fibers in the nerve simply are not in order *ab initio*. Any two contiguous fibers can come from the most widely separated points on the retina (*2*, *6*).

This finding strongly supports Sperry's hypothesis that optic-nerve fibers grow back to their original destinations. They do so in an even more highly specific way than he proposed; the regrowth of the termini is also proper in depth (*7*).

Note added in proof. After this manuscript was prepared we noted that R. M. Gaze, of the University of Edinburgh, has presented to the Physiological Society similar findings in *Xenopus laevis* (*8*). He, however, has not studied the reconstitution of the distribution in depth of the optic fibers.

H. R. MATURANA
Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, and *Department of Biology, Medical School, University of Chile, Santiago*

J. Y. LETTVIN
Department of Biology and *Research Laboratory of Electronics, Massachusetts Institute of Technology*

W. S. MCCULLOCH
W. H. PITTS
Research Laboratory of Electronics, Massachusetts Institute of Technology

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5 August 1959

Lunar and Solar Perturbations on Satellite Orbits

Abstract. Calculations of the solar and lunar effects on highly eccentric satellite orbits show that the sun and the moon may cause large changes in perigee height over extended periods of time. The amplitude and sign of the perigee height variations depend on the orbit parameters and the hour of launch; for a typical orbit and various choices of launch time, the perigee height will either rise or fall at the rate of 1 km/day over the course of several months. These results may be significant in deciding the launch conditions for future satellites with highly eccentric orbits.

A refinement of earlier computations on the orbit of the Vanguard I satellite has revealed the presence of a very slow variation in perigee height, with a period of 449 days and an amplitude of about 2 km. Kozai has suggested recently that a term of this period and amplitude will result from a combination of lunar and solar perturbations on that satellite (private communication). Kozai and Whitney have extended their calculations to the case of the paddle-wheel satellite, Explorer VI (Kozai, New York *Times*, 21 Aug. 1959). Explorer VI has an apogee of 48,700 km, a perigee of 6640 km, and an orbital inclination of 47.3° to the equator. Kozai and Whitney find that the highly eccentric orbit of this satellite produces substantial lunar and solar perturbations which decrease the perigee altitude rapidly, shortening its lifetime from several decades to a probable value of 2 years.

The very interesting work of Kozai and Whitney has encouraged us to explore further the possible lunar and solar effects on perigee height for satellite orbits of large eccentricity. We find that in general both the eccentricity and the perigee height vary with time as a result of these effects. The amplitudes, frequencies, and relative phases of the variations are determined by the orbit parameters and the hour of launch. For a special set of launch conditions, and for representative orbit parameters, the perigee height may be made to rise steadily over the course of several years at a rate of approximately 1 km/day. Thus the sun and the moon may provide a substantial perigee boost for the satellite under properly chosen circumstances. For other conditions the perturbations may be minimized to obtain a relatively stable orbit. These considerations may be of importance in deciding the launch programs for future satellites with highly eccentric orbits.

As a basis for our calculations we have used a convenient series development by Musen, which is equivalent to that of Kozai to our degree of accuracy.

In Musen's results the solar and lunar potentials appear as sums of trigonometric terms, whose arguments are combinations of the angles λ, ω, Ω, defined as follows: λ = mean longitude in orbit; ω = mean argument of perigee, measured from the line of the ascending node; Ω = mean longitude of the ascending node. When these symbols appear without subscripts they refer to the satellite; otherwise they refer to the sun or moon, as indicated by the subscripts e and m.

From the perturbing potentials we find the rate of change of perigee height by the method of variation of constants.

The results of the calculation are expressed most simply, in their dependence on the orbit elements, when the latter are defined with respect to the plane of the ecliptic. In terms of these elements, we can recognize five principal effects on the perigee height. Of these, four are resonances associated with the following conditions:

$$2\dot{\omega} - 2(\dot{\lambda}_e - \dot{\Omega}) = 0 \qquad (1a)$$

$$2\dot{\omega} + 2(\dot{\lambda}_e - \dot{\Omega}) = 0 \qquad (1b)$$

$$2\dot{\omega} - (\dot{\Omega}_m - \dot{\Omega}) = 0 \qquad (1c)$$

$$2\dot{\omega} + (\dot{\Omega}_m - \dot{\Omega}) = 0 \qquad (1d)$$

where $\dot{\omega}$, $\dot{\lambda}$, $\dot{\Omega}$, are the average angular velocities of ω, λ, Ω, respectively.

These resonance conditions have a simple interpretation. For example, in case 1a ($\lambda_e - \Omega$) represents the longitude of the sun relative to the line of nodes, and ω, the position of the perigee in the orbital plane, is also defined relative to the lines of nodes. Therefore, in a system in which the line of nodes is fixed the satisfaction of the resonance condition (case 1a) signifies that the mean angular velocities of sun and perigee are equal—that is, the line of apsides follows the sun. In this circumstance the orbital perturbation produced by the sun is clearly maximized.

In case 1b the sun and the line of apsides have the same period of revolution, but opposite directions. Again it is clear that the solar perturbation will be maximized. Cases 1c and 1d represent similar resonances keyed to the motion of the moon's orbital plane. The fifth effect is produced by the perturbations of the sun and moon averaged over many periods of revolution of these bodies. This term has a period of $2\pi/2\dot{\omega}$, or approximately 800 days for the case of Explorer VI.

We return now to the quantitative treatment of the perturbations. Let q be the perigee distance from the center of the earth. The rate of change of q is then found to have the following form:

$$\frac{dq}{dt} = + A_1 \sin(2\omega + 2\Omega - 2\lambda_e) + A_2 \sin(2\omega - 2\Omega + 2\lambda_e) + A_3 \sin(2\omega + \Omega - \Omega_m) + A_4 \sin(2\omega - \Omega + \Omega_m) + A_5 \sin 2\omega$$

The coefficients A_i depend on the size and shape of the orbit and on its inclination to the plane of the ecliptic. As this inclination varies, the relative importance of each term changes.

The effects on perigee height may be maximized or minimized by choosing suitable values of the orbital inclination and the time of launch. Long period effects occur when the inclination to the equator is near 63.4°—the critical angle at which there is no motion of the argument of perigee. At this inclination the 2ω term increases steadily with time. For an orbit with an apogee of 46,550 km and perigee of 6650 km the rate of change of perigee is approximately 1 km/day, as shown in Fig. 1. The sign and precise magnitude of the rate of change depend on the initial argument of perigee. The hour of launch does not affect this result.

At angles of inclination other than 63.4°, a variety of effects may be obtained by a suitable choice of the hour of launch. Selecting the hour of launch is equivalent to selecting Ω, the longitude of the ascending node, with any value available once in 24 sidereal hours. In Fig. 2, using the same apogee and perigee as in Fig. 1, an argument of perigee equal to 135°, and an equatorial inclination of 28° for 1 Feb. 1960, we show the results of three different choices of launch time. Curve A corresponds to a launch time of 7 hours U.T. on 1 Feb., curve B to 23 hours U.T., and curve C to 13 hours U.T. Cases A and C demonstrate rapid initial variations of perigee height. Case B represents a relatively stable orbit.

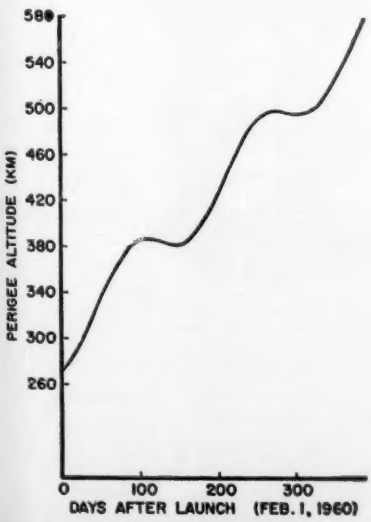

Fig. 1. Rate of change of perigee.

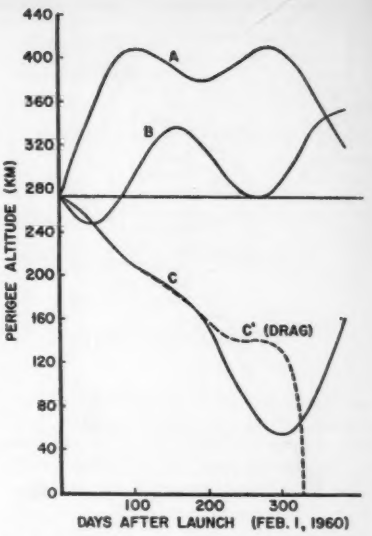

Fig. 2. Results of three different choices of launch time.

Curve C' represents the addition of drag to case C. It rises initially above the solar and lunar perturbation curve because the drag decreases the period and the eccentricity and these changes in turn decrease the solar and lunar perturbations. It is interesting to note that for a satellite with the parameters of Fig. 2, the lifetime is 25 years in the absence of lunar and solar perturbations, and approximately 1 year when they are included.

E. Upton
A. Bailie
P. Musen
Goddard Space Flight Center, National Aeronautics and Space Administration, Washington, D.C.

16 November 1959

Fat and Growth during Childhood

Abstract. Fat thickness, size, and maturity status are significantly correlated from 1.5 through 11.5 years in both sexes. Children who are fatter than their contemporaries at 8.5 to 9.5 years reach menarche earlier and complete epiphysial union sooner.

On the basis of available evidence an association would be expected between the amount of stored fat and size and maturity status in children during the growing period. Boys and girls from well-nourished populations are of greater

Table 1. Correlations between fat thickness and developmental status in boys and girls.

Lower-thoracic fat		Sex	Observations (No.)	Correlation coefficient (r)
At age (yr)	Correlated with			
1.5–11.5	Length*	F	471	0.41
1.5–11.5	Length*	M	685	0.32
12.5–17.5	Length	F	227	0.25
12.5–17.5	Length	M	284	0.04
8.5	Bone age	F	60	0.43
9.5	Bone age	M	61	0.35
12.5	Bone age	F	45	0.45
13.5	Bone age	M	63	0.26
8.5	Menarcheal age	F	59	0.34†
8.5	Tibial union	F	53	0.34†
9.5	Tibial union	M	56	0.47†

* Crown-heel length, 1.5 to 8.5 years; standing height, 9.5 to 17.5 years. †Reflected values of r (7).

stature and reach maturity earlier than children from less favored groups (*1*). Size during childhood is clearly related to economic level (*2*). Obese children have been reported to be taller than average and advanced in physiologic age (*3*).

In the study described here, the thickness of the fat-plus-skin shadow measured uniformly at the lower-thoracic site (*4*) on radiographs of children from 1.5 through 17.5 years was compared with length at the same ages. Fat thickness was further related to bone age (*5*) at a prepubertal and a pubertal developmental horizon, and fat thickness at 8.5 to 9.5 years was correlated with age at menarche in girls and with the age of completion of epiphysial union in the tibia in both sexes. Normalized T-scores obtained according to McCall's method were utilized throughout (*6*, *7*), both to eliminate skewness and to provide age- and sex-specific measures for the correlations.

In 1667 separate observations on 259 clinically healthy white children, fat and size were found to be unquestionably related during the growing period. For children aged 1.5 through 11.5 years, age-specific correlations ranged up to 0.6, and over-all fat-length correlations (on the basis of sex- and age-specific T-scores) were 0.41 in girls and 0.32 in boys (Table 1). Thereafter, correlations between fat and length, though still positive, generally failed to attain the 5-percent level of confidence.

In similar fashion, fat thickness and bone age were positively correlated at the two developmental horizons considered. Further, girls who were fatter at 8.5 years of age attained menarche earlier, the correlation coefficient being 0.34. The long-term concomitants of fat were further demonstrated by similar correlations between fat thickness at 8.5 to 9.5 years and the time of complete union of the tibial epiphyses (see Table 1).

To translate these findings into developmental equivalents, increases of 1 standard deviation (10 T) above the average in fat thickness were associated with increases in stature of up to 0.45 of a year's growth at 11.5 years of age. Children with fat thickness of 1 standard deviation above the average were advanced in bone development at the particular ages investigated by an average of 0.25 to 0.54 year. Girls comparably fatter than the average at 8.5 years of age reached menarche 0.48 year earlier. A comparable relationship was observed between fat thickness at 8.5 to 9.5 years of age and the time of tibial union: the fatter boys and girls were advanced by 0.6 and 0.4 year, respectively.

Clearly, fatter children are both advanced in maturity and taller during the growing period (*8*). They reach menarche earlier, on the average, and complete tibial growth sooner. The data reported here, however, do not indicate whether the size advantage persists after completion of epiphysial union, and whether there is an asymptotic point beyond which greater-than-average fatness is no longer associated with accelerated development (*9*).

STANLEY M. GARN
JOAN A. HASKELL
Physical Growth Department,
Fels Research Institute,
Yellow Springs, Ohio

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5 August 1959

Meetings

Laboratory Animal Breeders

The charter meeting of the Laboratory Animal Breeders Association was held in Chicago on 2 December 1958. A large number of the breeders of the country attended. The membership, which now numbers 56, includes most of the large commercial breeding organizations of the country, in addition to many producers who operate on a smaller scale. In order that the attitudes of all breeders may be represented, the constitution of the association provides that each member organization shall have one vote. The excellent attendance at the first meeting indicates that within another year almost 100 percent of the commercial breeders in the United States will be members.

The membership as a whole participated in the development and adoption of the constitution and bylaws and elected officers as follows: president, J. C. Kile, Jr.; vice president, Henry L. Foster; second vice president, Clyde K. Miller; and secretary, Elizabeth J. Simonsen. Regional representatives to the executive committee were appointed.

There has been much consideration given over the past several years to establishment of a program for accrediting the facilities of laboratory animal breeders. It is hoped that in the next few years the Laboratory Animal Breeders Association will be able to sponsor and participate in establishing a program such as this. A committee to consider regulatory activities was appointed.

Since there is a need for expansion of knowledge in the field of laboratory animal husbandry, a committee on research was designated to consider animal-husbandry projects which the organization or the members may undertake and to coordinate such activities and accumulate information relative to the many problems involved.

An extremely important consideration is the relationship of the association with other areas of the laboratory-animal industry. An editorial and publicity committee was appointed to advise members of the industry other than the commercial breeders of the existence of the organization and to keep them abreast of activities as the program develops.

A committee on shipping relations was appointed to study current rates for shipping laboratory animals.

Guest speakers at the charter meeting were L. R. Christensen (director of the Berg Institute, New York University); Berton F. Hill (executive secretary of the Institute of Laboratory Animal Resources); and W. T. S. Thorp (dean, College of Veterinary Medicine, University of Minnesota).

ELIZABETH SIMONSEN
Simonsen Laboratories,
Gilroy, California

Forthcoming Events

January

18–21. American Astronautical Soc., 6th annual, New York, N.Y. (A. P. Mayernik, AAS, 6708 53 Rd., Maspeth 78, N.Y.)

19–21. American Meteorological Soc., 40th annual, Boston, Mass. (K. C. Spengler, 3 Joy St., Boston.)

19–21. Congenital Malformations, CIBA symp. (by invitation only), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

21–23. American College of Surgeons, Louisville, Ky. (H. P. Saunders, 40 E. Erie St., Chicago 11, Ill.)

23–28. American Acad. of Orthopedic Surgeons, Chicago, Ill. (J. K. Hart, 116 S. Michigan, Chicago 3.)

24–29. American Rocket Soc., Princeton, N.J. (J. J. Harford, ARS, 500 Fifth Ave., New York 36.)

25–28. Institute of the Aeronautical Sciences, 28th annual, New York, N.Y. (IAS, 2 E. 64 St., New York 21.)

25–28. Plant Maintenance and Engineering Show, Philadelphia, Pa. (R. S. Wolcott, Clapp & Poliak, 341 Madison Ave., New York 17.)

25-29. Stress Measurement Methods, symp., Tempe, Ariz. (P. K. Stein, Strain Gage Readings, 5602 East Monte Rosa, Phoenix, Ariz.)

27–28. College-Industry Conf., Amer. soc. for Engineering Education, St. Louis, Mo. (W. L. Collins, ASED, Univ. of Illinois Urbana.)

27–28. Group Therapist, His Personality, Training, and Functions, 4th annual, AGPA, New York, N.Y. (American Group Psychotherapy Assoc., Inc., 1790 Broadway, New York 19.)

27–29. American Mathematical Soc., 66th annual, Chicago, Ill. (J. W. Green, Univ. of California, Los Angeles 34.)

27–30. American Physical Soc., annual, New York, N.Y. (K. Darrow, APS, Columbia Univ., 116 St. and Broadway, New York.)

28–30. Mathematical Assn. of America, 43rd annual, Chicago, Ill. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

28–30. Western Soc. for Clinical Research, 13th annual, Carmel-by-the-Sea, Calif. (W. N. Valentine, Western Soc. for Clinical Research, Univ. of California Medical Center, Dept. of Medicine, Los Angeles 24.)

29–30. American Group Psychotherapy Assoc., Inc., 17th annual conf., New York, N.Y. (American Group Psychotherapy Assoc., Inc., 1790 Broadway, New York 19.)

31–5. American Inst. of Electrical Engineers, New York, N.Y. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

31–7. Pan American Cong. of Ophthalmology, 6th, Caracas, Venezuela. (J. W. McKinney, 921 Exchange Bldg., Memphis, Tenn.)

February

1–4. American Soc. of Heating, Refrigerating and Air Conditioning Engineers, semi-annual, Dallas, Tex. (Miss J. I. Szabo, ASHRACE, 234 Fifth Ave., New York 1.)

1–4. Instrument-Automation Conf., Houston, Tex. (Director, Technical and Educational Services, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22.)

1–5. American Inst. of Electrical Engineers, winter general, New York, N.Y. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

2–4. Haemopoiesis—Cell Production and Its Regulation, Ciba Foundation symp. (by invitation only), London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1, England.)

2–4. Society of the Plastics Industry (Reinforced Plastics Div.), Chicago, Ill. (W. C. Bird, SPI, 250 Park Ave., New York 17.)

3–5. Military Electronics, IRE winter conv., Los Angeles, Calif. (G. B. Knoob, Motorola, Inc., Military Electronics Div., 1741 Ivar Ave., Hollywood 28, Calif.)

3–6. Parathyroid Research, symp., Houston, Tex. (R. V. Talmage, Dept. of Biology, Rice Inst., Houston.)

4–6. American Soc. for Metals, San Francisco, Calif. (R. Huggins, ASM, Stanford Univ., Stanford, Calif.)

4–6. Congress on Administration, 3rd annual, Chicago, Ill. (R. E. Brown, American College of Hospital Administrators, 840 N. Lake Shore Drive, Chicago 11.)

7–10. Radioactive Isotopes in Clinical Medicine and Research, 4th intern. symp., Bad Gastein, Austria. (R. Höfer, 2nd Medical Univ. Clinic, 13 Garnisongasse, Vienna 1X, Austria.)

10–11. Gas Cooled Reactor, symp., Philadelphia, Pa. (F. L. Jackson, Franklin Inst., Philadelphia, Pa.)

10–12. Solid States Circuit Conf., Philadelphia, Pa. (T. R. Finch, Bell Telephone Laboratories, Murray Hill, N.J.)

10–13. National Assoc. for Research in Science Teaching, 33rd annual, Chicago, Ill. (C. M. Pruitt, Univ. of Tampa, Tampa, Fla.)

10–13. National Soc. of College Teachers of Education, Chicago, Ill. (E. J. Clark, Indiana State Teachers College, Terre Haute.)

11. Protein and Amino Acid Requirements of Swine, Chicago, Ill. (J. T. Sime, Assoc. of Vitamin Chemists, Evaporated Milk Assoc., 228 N. La Salle St., Chicago 1.)

14–18. American Inst. of Mining, Metallurgical and Petroleum Engineers, annual, New York, N.Y. (E. O. Kirkendall, AIME, 29 W. 39th St., New York 18.)

16. Astronomical Soc. of the Pacific annual, San Francisco, Calif. (S. Einarsson, Leuschner Observatory, Univ. of California, Berkeley 4.)

18–19. Chemical Inst. of Canada (Protective Coatings Div.), Toronto, Ont., and Montreal, Que., Canada. (Scientific Liaison Office, National Research Council, Sussex Drive, Ottawa, Canada.)

18–20. National Soc. of Professional Engineers, winter, Wichita, Kan. (P. H. Robbins, NSPE, 309 Bancroft Bldg., Univ. of Nebraska, Lincoln.)

21–24. American Inst. of Chemical Engineers, Atlanta, Ga. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36.)

22–25. Technical Assoc. of the Pulp and Paper Industry, annual, New York, N.Y. (J. Winchester, TAPPI, 155 E. 44 St., New York 17.)

22–4. Scientific Management, 12th intern. cong., Sydney and Melbourne, Australia. (C. M. Gray, Federal Council of the Australian Inst. of Management, Western House, 83 William St., Melbourne, C.1, Victoria, Australia.)

24–26. Biophysical Soc., 4th annual, Philadelphia, Pa. (O. H. Schmitt, Biophysical Soc., Chairman, Program Committee, Univ. of Minnesota, Minneapolis.)

25–27. Cell Physiology of Neoplasia (14th annual symp. on fundamental cancer research), Houston, Tex. (Editorial Office, Univ. of Texas M. D. Anderson Hospital, Texas Medical Center, Houston 25.)

26. Highway Geology, 11th annual symp., Tallahassee, Fla. (W. F. Tanner, Geology Dept., Florida State Univ., Tallahassee.)

29–4. Pittsburgh Conf. on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, Pa. (L. P. Melnich, U.S. Steel Corp., Monroeville, Pa.)

March

3–5. American Acad. of Forensic Sciences, Chicago, Ill. (W. J. R. Camp, AAFS, 1853 W. Polk St., Chicago 12.)

4–6. National Wildlife Federation, Dallas, Tex. (C. H. Callison, 232 Carroll St., NW, Washington 12.)

7–9. Wildlife Management Inst., Dallas, Tex. (C. R. Gutermuth, 709 Wire Bldg., Washington 5.)

7–11. American Soc. of Civil Engineers, New Orleans, La. (E. S. Kirkpatrick, ASCE, 33 W. 39 St., New York 18.)

10. Recent Developments in Poultry Nutrition (Assoc. of Vitamin Chemists), Chicago, Ill. (J. T. Sime, Director of Research, Evaporated Milk Assoc., 228 N. La Salle St., Chicago 1.)

14–16. American Railway Engineering Assoc., annual conv., Chicago, Ill. (N. D. Howard, AREA, 59 E. Van Buren St., Chicago 5.)

14–17. Positive Health of Older People, forum, Miami Beach, Fla. (A. Mallach, National Health Council, 1790 Broadway, New York 19.)

15–21. Nondestructive Testing, 3rd intern. conf., Tokyo and Osaka, Japan. (S. Ishizaka, Scientific Attaché, Embassy of Japan, 2514 Massachusetts Ave., NW, Washington 8.)

17. Congress for Pharmacists, 2nd annual, Jamaica, N.Y. (Congress for Pharmacists, Public Relations Office, St. John's Univ., Jamaica 32.)

17–19. American Radium Soc., conf., San Juan, Puerto Rico. (ARS, 635 East Union, Pasadena, Calif.)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science *nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to the manufacturer. Include the department number in your inquiry.*

■ X-Y PLOTTER features static accuracy said to be ±0.1 percent of full scale and dynamic accuracy ±0.2 percent of full scale at 10 in./sec tracing speed. Speed of response is 20 in./sec on either axis. Paper is held on a flat vacuum platen. Push-button controls are provided for *X* and *Y* scales, vacuum, plot clear, four-quadrant plot, reference plot, *X-Y* reference continuous trace, and manual plot. Plotting is controlled by panel pushbutton or at remote location. (Librascope, Inc., Dept. Sci267, Glendale, Calif.)

■ CARDIAC PACEMAKER is designed to stimulate ventricular function, during and after surgical repair of septal defects, by internal application with at least one wire attached directly to the myocardium for temporary stimulation or with a bipolar patch for prolonged stimulation. Output pulse is a square wave of approximately 2-msec duration. The self-contained power source will operate the transistorized device approximately 1000 hr. Dimensions are 4 by 2½ by 1 in. (Medtronic, Inc., Dept. Sci269, 818 19 Ave. NE, Minneapolis 18, Minn.)

■ ELECTROMAGNET is available in two models, the LM4-AG with adjustable gap and the LM4-FG with fixed gap specified by the purchaser. Replaceable pole caps are 4, 6, and 8 in. in diameter. Tapered pole caps are available. A thermocouple buried in the wire-wound coils permits monitoring of temperature, and water-cooled panels are built into the coils. Coils are tapped at 3 and 16 percent of turns. Coil current is 2.5 amp (max.) and voltage, hot, is 300 volts. Total turns, 11,000. (Applied Radiation Corp., Dept. Sci274, 2404 N. Main St., Walnut Creek, Calif.)

■ SIGNAL SCANNER is capable of switching up to 400 one-wire, 200 two-wire, or 100 four-wire inputs. With properly shielded input and output connections, it is said to be possible to switch signals as low as 10 μv. Start channel number and stop channel number may be preset from 000 to 999 by six selector switches. Operation can be automatic or manual, with single cycle or continuous cycling in the automatic mode. (Kin Tel Div., Cohu Electronics, Inc., Dept., Sci276, 5725 Kearny Villa Rd., San Diego 12, Calif.)

JOSHUA STERN
National Bureau of Standards, Washington, D.C.

Letters

(Continued from page 1678)

map (Fig. 1) is confusing unless one colors it or uses both the Raritan folio (1/125,000) and the Stanhope (N.J.) topographic quadrangle (1/24,000) for reference.

WILLIAM J. WAYNE
Indiana Geological Survey, Bloomington

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1. J. P. Minard, *Science* **129**, 1206 (1959).
2. M. M. Leighton and P. MacClintock, *J. Geol.* **38**, 28 (1930); W. D. Thornbury, *Indiana Dept. Conserv. Div. Geol. Publ.* (1937); W. J. Wayne, *J. Geol.* **66**, 8 (1958).
3. R. D. Salisbury, *New Jersey Geol. Survey Publ. No. 5* (1902), pp. 451-460.
4. W. S. Bagley, R. D. Salisbury, H. B. Kummel, *U.S. Geol. Survey Folio No. 191* (1914), p. 18.
5. C. S. Denny, *Ohio J. Sci.* **51**, 116 (1951).
6. P. MacClintock, *Bull. Geol. Soc. Am.* **51**, 103 (1940).
7. C. B. Hunt and V. P. Sokoloff, *U.S. Geol. Survey Profess. Paper No. 221-G* (1950), pp. 117-118.

J. P. Minard presents some interesting observations with respect to the presence of deeply weathered bedrock immediately north of the Wisconsin glacial moraine in New Jersey. The author relates this deep-seated weathering to post-Wisconsin time. That the saprolite exists in the area is not questioned. Relating the weathering of the bedrock to post-Pleistocene time, however, raises some serious questions. The author's interpretation of when this weathering took place is in direct contradiction to publications of mine (*1–3*), and it does not agree very well with the bulk of the published opinion of surficial geologists (*4, 5*).

One feature which appears to be quite characteristic of soils on deposits of post-Sangamon age in the podzolic area is that the bottom of the B horizon is very distinct, grading abruptly into a C horizon of comparatively fresh material. Below the B horizon the minerals (*3*) and the morphology show few changes since deposition of the till. This unaltered C horizon is not only demonstrable in the field throughout the northeastern United States and southeastern Canada but has been well documented in countless publications on soils for nearly half a century.

With soils which pre-date the Wisconsin glacial stage, a deep-seated weathering has taken place to depths of many feet, often well into the bedrock. Soils which have undergone the long periods of weathering of the Yarmouth and Sangamon interglacial stages show only minor color variations between the B and C horizons, the C horizon having been highly altered (*2*).

If the weathering processes were deep-seated during post-Wisconsin time, why were they confined to one locality? Certainly major climatic changes were not so highly localized as to effect major alterations in one specific area while effecting no appreciable weathering below the solum in other, contiguous areas of Wisconsin glaciation. We cannot, on the one hand, speak of deeply weathered and differentially altered minerals of gneissic bedrock to a depth of 10 to 20 feet below the surface in one location and completely ignore the widespread persistence of unweathered carbonate and other minerals 2 to 4 feet below the surface in the same general area.

The author indicates that the lack of "congeliturbate structure" would preclude the probability that the regolith was frozen during glaciation. The absence of special structural conditions (induced by cryopedologic processes) in the soil in one locality in itself proves little. While it has been demonstrated (*5*) that cold-climate processes did operate to a degree in Wisconsin glaciated areas, field observations clearly show that these well-defined cold-climate structures are more commonly absent than present.

The author's arguments for rapid weathering at the site prove little, and the references cited have only indirect relation to the subject. It is unfortunate that the voluminous literature relating directly or indirectly to the lack of deep-seated weathering in deposits of Wisconsin age was not tied in with the article.

In addition to the site mentioned by the author, there are other, similar locations in New Jersey within the area of Wisconsin glaciation which show deep-seated weathering. These scattered atypical conditions appear to be confined to a belt a few miles wide immediately north of the Wisconsin terminal moraine. If the sites were glaciated, there must have been a minimum of glacial scouring. On the basis of regional soil morphology in the fringe areas of the Wisconsin-glaciated area, these scattered highly weathered soils appear to resemble more closely those of deposits of Illinoian and Kansan age (Annandale) than those of Wisconsin age (Rockaway).

While I disagree with Minard's interpretations as to when the weathering of the bedrock took place, his recording of the observation in itself represents an important contribution to Pleistocene research.

J. C. F. TEDROW
Soils Department, Rutgers University, New Brunswick, New Jersey

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1. J. C. F. Tedrow and A. S. Wilkerson, *Soil Sci.* **75**, 345 (1953); R. D. Krebs and J. C. F. Tedrow, *ibid.* **85**, 28 (1958).
2. J. C. F. Tedrow, *Soil Sci. Soc. Am. Proc.* **18**, 479 (1954).
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5. C. S. Denny, *U. S. Geol. Survey Profess. Paper No. 288* (1956).

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